ABSTRACT VOLUME

World Water Week in Stockholm
26 – 31 August 2018

Water, ecosystems and human development

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Seminar: Tapping into collective wisdom: Gender sensitive development and water ecosystems

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Seminar: Tapping into collective wisdom: Gender sensitive development and water ecosystems

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An alternative gender analytical approach for water governance

Presenting: Ms. Laura Imburgia, University of Reading, United Kingdom
Author: Ms. Laura Imburgia, University of Reading, United Kingdom

Keywords
Analytical Frameworks, Gender, Irrigation, Governance, Social Relations

Highlights
- The abstract presents an alternative analytical framework to examine the issues involved in water governance and gender participation.
- The approach helps examine the extent to which gender is a significant driver of participation in irrigation management.
- Its application is illustrated by empirical evidence from Ethiopia and Argentina.

Introduction and objectives
It is widely recognised that rural women are important irrigation water users, in particular those dependent upon small scale agriculture. Although there has been increasing attention to the question of women as users of water for agriculture (Ahlers and Zwarteveen, 2009; Udas, 2014; Buisson et al., 2017), a comprehensive analysis examining all interrelated factors, with a methodology going beyond the case study approach is missing. This article uses an alternative analytical framework to examine the gendered outcomes of irrigation management through the perspective of social relations of power and its contribution to gender equality in water policy.

Methodology approach
The construction of this framework was based on reviewing relevant existing analytical approaches and the analysis of empirical data from two contrasting settings, small scale irrigation systems in Ethiopia and Argentina. The approach is used to examine the question: what are the outcomes of the interactions of dynamics of gender, social relations and irrigation practice within the context of collective water governance? The understanding of the mechanisms that govern those intersections is of particular relevance for the understanding of how natural resource management, including water management, is gendered. This in turn can help addressing gender differences towards broader social equality.

Analysis and results
The use of this analytical approach allows to understand and describe gender differences in access, use and participation of different groups of irrigation water users. Applied to the irrigation management sector of Mendoza Province, centre-west of Argentina, this analysis provides an example of how even in a technically robust and well established democratic water management system, gender-based constraints to participation and decision making by women persist.

The analysis of water users' associations of Tigray, Ethiopia, shows that formal and more transparent forms of organisations of irrigation users have visibly improved security of access to irrigation water of certain groups of female farmers. In both Tigray and Mendoza, women appear to have a very low participation in the governance of irrigation systems due to a number of contextual, but also similar constraints. This imbalance in participation has practical implications, which become particularly apparent in the small scale irrigation sector.

Empirical evidence from both countries indicates that women claiming participation in the male dominated sector of water resource governance often have to confront culturally rooted ideologies and power structures, often at a personal cost. This appears to also be the case elsewhere (for example, Vera Delgado, 2005; Udas and Zwarteveen, 2010).
Conclusions and recommendation
This study has helped explain why some groups of women find it harder to overcome constraints in the irrigation management sector. It also highlights opportunities and conducive sector policies. Gender integration policies are strongly needed in the irrigation sector of both regions, despite considerable environmental, socio-economic and cultural differences. Interestingly, Ethiopia appears to have a more advanced gender and agriculture policy framework.

The most frequent scale of analysis of women’s participation in water resource management has been the local level. The transition from community to higher levels of collective gender participation is of substantial interest in this study.
Circular economy practices for exotic vegetables cultivation of women farmers

Presenting: Ms. Priska Prasetya, WASTE, Netherlands
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Keywords
Circular Economy, Women Farmers, Blackwater Recycling, Greywater Recycling, Climate-Smart Agriculture

Highlights
Under Securing Water for Food (SWFF) project, women farmers in Nilgiris implement circular economy principles through the recycling of black and greywater for compost production and irrigation of exotic vegetables cultivation respectively. The women farmers are organised into Producer Companies. Through these companies marketing partners advance money for vegetables under cultivation (advance purchase orders).

Introduction and objectives
The economic condition in the Nilgiris District, India depends on the success and failure of horticulture crops. Climate change has resulted in limited water availability for 4-6 months. Excessive application of chemical fertilisers has resulted in declining soil fertility. Additionally, solid and liquid waste in the area are inadequately treated and disposed irresponsibly to the environment.
To change this negative cycle, we introduce the circular economy principles, with black and greywater recycling for compost production irrigation of exotic vegetables by women farmers respectively. The objective is to increase women farmers’ income by extending crop season and improving soil quality with compost for increased yield.

Methodology approach
Women farmers in Nilgiris are accustomed with growing, processing, and sales of exotic vegetables to market. A total of 2250 women farmers will get organised into Producers Companies located in Nilgiris for linkage with marketing partners and banks for loans.
Blackwater are collected by honesuckers from women farmers’ households and transported to a treatment site in which the dried sludge gets mixed with collected organic solid waste for composting. Greywater are sourced from a cluster of women farmers’ households into a treatment area in which the treated water goes into a pond for irrigation for use by women farmers.

Analysis and results
A baseline assessment has been undertaken among women farmers about their situation and their view on comprehensive recycling. It was observed that all of them use compost and some of them are already familiar with co-compost from the mixing of faecal sludge and organic waste, which would later help in the adoption process of the product. Additionally, they also expressed the need to have more water availability during dry months.
Blackwater from women farmers’ households will be treated with a wetland system in which the dried sludge gets mixed with collected organic solid waste for composting at government-owned treatment site. Greywater from women farmers’ households will be treated with a natural system in which the treated water will be collected in a collective farm pond for women farmers to use for irrigation. It was observed that the community has their own traditional system for sharing of public good. Discussions with the village leaders have been held and a new collective system will be decided among women farmers on distribution of treated greywater for irrigation purpose.
Women farmers are registered under Producer Companies. They are developing business plans for banks and MoU with marketing partner for the procurement of their crops.

**Conclusions and recommendation**

Women farmers have expressed demand for compost (with the mix of faecal sludge and organic solid waste) and additional water availability. A methodological monitoring and evaluation must take place to ensure safety and quality of compost for soil application and treated greywater for irrigation. Additionally, trainings will be conducted and SOP developed for women farmers on how to operate and manage greywater treatment units and undertake household composting. These will also be developed for honey sucker operators on the handling of blackwater and women workers at centralised treatment site on composting and handling of dried sludge and organic waste.
Gendered approach in capitalising on traditional knowledge: A case study

Presenting Author: Dr. Uttam C. Sharma, Centre for Natural Resources Management, India

Keywords
Gendered approach, Traditional knowledge, Apatani valley, Water ecosystem, Case study

Highlights
Based on the traditional knowledge of the tribal people in Northeast India, Apatani plateau was transformed from a water deficit to water sufficient region for raising crops, fisheries, livestock and domestic use. The region is now called the ‘Rice Bowl’ of the region, inducing women empowerment and quality of life.

Introduction and objectives
Water is main driver for combating poverty and achieving sustainable development and sustaining ecosystems. It reflects the social differences that impact women’s empowerment. Gender differentiated indigenous knowledge systems have placed such concerns within a broader social and institutional context. The indigenous water management system of Apatani tribe of Arunachal state of India has been developed due to ingenuity and skill of the tribal farmers, which has sound gender base and remarkable labour distribution pattern. Combination of indigenous knowledge and interventions with modern technologies have made the system more productive ad improved the ecosystem for delivering more ecosystem services.

Methodology approach
Streams from the hills are tapped soon after these emerge from the forest, channelized at the rim of the valley and diverted by a network of primary, secondary and tertiary channels. The feeder channel conveys water through the series of terraces, so that by blocking or opening the connecting ducts (Huburs), any field can be flooded or drained. These channels are generally pitched with boulders to checks erosion. Farmers drain off the water from the rice fields twice during tillering, once during flowering and finally at maturity. Fish channels are dug at various locations in the rice fields.

Analysis and results
The Apatani tribe has developed unique water management system, which remained sustainable for centuries because of its sound scientific base and dependence on locally available resources. A well-marked division of labour is generally followed for various operations. Men folk generally take care of hard works like, building terraces, irrigation channels, fencing, removing earth and planting trees; while women folk look after nurseries, transplanting, weeding, fish, harvesting, threshing, drying and storage. Some of the operations like fencing and maintenance of main irrigation channels are done on community basis. A proper code for erection of risers as well as maintenance and release of water for irrigation is followed. Community gangs of boys and girls are always ready to help each other in various operations. Interventions were made in the system with regard to enhanced role of women, improved crop varieties, fish farming, soil fertility improvement, access to bank loan and marketing for improving crop productivity, environment and water ecosystem. Apart from conservation, farmers have taken up the plantation of Terminalis myrinalia, Altingia excelsa, Michelia sp., Magnolia sp., Pines and bamboos to keep entire hills surrounding the valley as conserved forest. This helped in conserving of natural resources and maintenance of ecological balance.
Conclusions and recommendation
The Apatani tribe has developed unique water management system, which has remained sustainable for centuries because of its sound scientific base and dependence on locally available resources. Since no inorganic fertilizer are used, there is no pollution of surface and ground water regimes in the area. Improving these land use systems with state-of-the-art technologies in water and soil conservation has ensured judicious rainwater management, reduction in soil erosion, environmental compatibility, leading to healthy ecosystem and livelihood security. Proper policy framework for planning, taking advantage of the advances made in water science combined with indigenous knowledge, would improve ecosystem services.
‘Green Lady of Bihar’ and sustainable watershed management in India

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Keywords
Watershed management, India, sustainable development, gender, equity

Highlights
This presentation will highlight how sustainable watershed management has been organized in Dharhara Kol, a socio-economically backward region in Bihar, India through participation of local women and men under the able leadership of the ‘Green Lady of Bihar’, Jaya Devi. This has led to sustainable development.

Introduction and objectives
Women’s participation in water resources management has been long endorsed as desirable and several ‘top-down’ approaches have been applied towards this end, though not every effort has delivered the goods. In comparison to top-down approaches, ‘bottom-up’ approaches have greater acceptability and sustainability. This presentation aims to describe a case of bottom-up women’s participation from India under the leadership of a local woman leader Jaya Devi, who belongs to a socio-economically backward class. Under her guidance several villages in a water-stressed poverty-stricken area have brought about revival of their water ecosystems and consequently sustainable and equitable development.

Methodology approach
The presentation is based on the findings of an empirical research in Dharhara-Kol, a socio-economically backward region in Bihar state of India. Data was collected through qualitative research methods in selected villages in two watersheds led by Jaya Devi, namely Kareli and Koilu. The study was based on the framework of IWRM, conceptualized as an approach promoting coordinated restoration and management of water and other natural resources, with the aim to maximize equitable development together with ecosystems sustainability. ‘Integration’ primarily focused on: green and blue waters, different water use sectors, and involvement of all villagers in planning and action.

Analysis and results
Dharhara Kol is a rain-shadow area with only 700-800 mm rain annually, which also becomes lost due to the hilly undulating terrain. As a result, until recently the region comprised bare hill slopes, barren uncultivated lands, with low water table, resulting in poor agricultural productivity and hence limited livelihoods and widespread poverty. Water was brought to the region by Jaya Devi, a local rural woman, through her relentless efforts at gender-sensitive community-based watershed management. She has untiringly motivated and organized women and men in the various watershed villages into self-help groups and village watershed committees to work together to undertake rainwater harvesting and water conservation practices. These efforts have delivered unbelievable results, leading to effective water resources management that enhanced ‘blue water’ storage on the surface and ‘green water’ retention in the soil. This made hillslopes turn green, agricultural production boost several times, and added new livelihood options. About 9000 families living in six watersheds where she has worked have benefited immensely, and over 5000 hectares of barren land turned into green belt. Her efforts at bringing water in the barren Dharhara Kol region have brought her many awards and accolades, such as the ‘Real Heroes’ award and the National Youth Award. She is also recognised as the ‘Green Lady of Bihar’ and the ‘Water Lady of India’.
Conclusions and recommendation

Jaya Devi’s efforts and the successes it has brought to her area in terms of water security and sustainable and equitable development is an eye-opener. A local woman who is barely educated upto primary level has brought not only empowerment for herself, but ushered in a new era of empowerment for her poverty-stricken community through ecosystem- and IWRM-based approach. There is need to promote women’s participation from ‘bottom-up’ in this manner by motivating and supporting local women leaders who are accepted by the community in terms of their own criteria rather than through ‘top-down’ approaches.
Human rights to water and sanitation for indigenous peoples

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Keywords
human rights, gender, indigenous, WASH, Latin America

Highlights
Balancing the scientific approach with a sustainable solution at river basin level is extremely challenging and requires a holistic approach. Governance policies for indigenous people in Latin America are analysed to see how they support the realisation of the human rights to water and sanitation at river basin level.

Introduction and objectives
The human rights to water and sanitation are an obligation under international law for all people to have the rights to access, under safe conditions. Equally, people have the right to a healthy environment. The two rights are intrinsically linked, not just as rights, but also from a water management perspective. While the status of laws and policies at a river basin level may recognise these rights in international and national frameworks, the practical processes for introducing workable policies, monitoring and compliance are often far from being realised, and can ignore the rights of indigenous peoples.

Methodology approach
WaterLex conducts legal and policy mapping at country or river basin level, to see how the HRWS is being met, where are the gaps, and how to monitor human rights sensitive data to help realise the rights. Recent research in four countries in Latin America has highlighted the rights of women and indigenous peoples, as these groups are often the ones at highest risk of lacking access to safe water and sanitation, exacerbating poor conditions.
The research is practical, as well as analytical, and we engage with stakeholders from these countries to build on our research.

Analysis and results
The paper will be a case study of best practices from four countries in Latin America (Guatemala, Nicaragua, El-Salvador and Honduras), comparing practical governance solutions for implementing the human rights to water and sanitation, especially looking at the balance between natural ecosystem solutions and the needs of people in rural and environmentally sensitive areas. Given the high proportion of indigenous people in Latin America (80% in Guatemala for example); the traditional inclusion of women as water managers and carers in the family; the impact of poor WASH services in the region in general (62% with access to safe water, and less than 50% to safe sanitation); the impact affects women, children and indigenous people to a higher extent than the rest of the population.
These case studies will be looking at practical advice on how to include a human rights-based approach to consultation, keeping non-discrimination, transparency of data and participation in mind. It also examines the role of National Human Rights Institutions to help monitor the situation, advise government, and help to trigger changes in behaviour.
Conclusions and recommendation

The conclusion of the case study report will highlight the best examples of governance approaches from each of the countries in dealing with the issues surrounding access to water and sanitation for indigenous people, and in particular for the inclusion of women in the decision-making process. The conclusions are readily estimable, given the high connectivity between poverty and lack of WASH services. The ability to include nature-based solutions, and integrate indigenous peoples into the process, especially women, helps to achieve a more holistic approach to water resource management and development will surely provide more sustainable solutions for all.
Integrating indigenous and scientific drought forecasts empowers Africa’s women small-holder farmers

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Co-Authors: Mr. Adeyinka Kabir, AKANBI

Keywords
Indigenous Knowledge, Drought Early Warning System, Seasonal Climate Forecasts, Sub-Saharan Africa, Women small-holder farmers

Highlights
• Integrating indigenous knowledge (IK) on droughts with the seasonal climate forecasts improves the accuracy of droughts forecasts for small-holder farmers.
• More than 60% of these farmers are women who are illiterate for whom scientific forecasts are irrelevant.
• Incorporation of IK makes the forecasts relevant and hence increases willingness to use.

Introduction and objectives
The fact that over 70% of food produced in Africa comes from vulnerable rain-fed small-scale farms, makes them vulnerable to rampant droughts. To address this, we present a drought early warning system that integrates indigenous knowledge and scientific drought forecasting approaches using mobile phones, wireless sensor networks and artificial intelligence. The resulting system is called ITIKI. With over 60% of the participants being semi-literate women, the system has resulted in more empowered women who are now able to make sound cropping decisions. Tests from African 3 countries indicate forecasts’ accuracies of 78-98% for lead-time of up to 4 years.

Methodology approach
A series of structured interviews as described in were used to collect primary data from five communities: Mbeere, Nganyi and Taital of Kenya, then Ndau of Mozambique and finally Zulu from South Africa. Scientific weather data was collected from conventional weather stations, sensor-based weather stations as well as from historical weather data. This was then followed by the development of an integration framework that takes the form of a generic early warning system consisting of four components: gathering of the risk knowledge, monitoring and predicting the situation, communicating the warning messages and responding to the warning.

Analysis and results
This is a novel drought-monitoring and predicting solution that works within the unique context of small-scale farmers in Sub-Saharan Africa. It is a sustainable, relevant and an empowering tool for women small-holder farmers. The system uses mobile phones as input/output devices and wireless sensor-based weather meters to complement weather stations. The system has been deployed and tested in Kenya, Mozambique and South Africa. The robustness of the system is anchored on artificial neural networks that support forecast models with accuracies of 70% to 98% for lead-times of up to 4 years. Fuzzy logic is used to store and manipulate the holistic indigenous knowledge.
Conclusions and recommendation

The now more rampant and severe droughts have become synonymous with Africa; they are a major contributor to the acute food insecurity. The uniqueness of the problem is the ineffectiveness of the drought monitoring and predicting tools in use in. The main form of forecasts is the Seasonal Climate Forecasts (SCFs) whose utilisation by the semi-illiterate small-scale farmers is below par. By integrating indigenous knowledge Forecasts and SCFs, accuracies are greatly improved and the majority of these farmers, who happen to be women, are empowered with a usable cropping decision tool. This way, we contribute towards food security in Africa.
Monitoring SDGs 6, 5 and 14 through gender analysis tools

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Keywords
Gender-sensitive freshwater assessments, sex-disaggregated water data, SDGs, water policies

Highlights
1. Explore the interlinkages between SDG5, SDG6 and SDG 15
2. Combining gender equality and water management targets
3. Operationalize SDG targets at project level
4. Understanding gender role differences through sex-disaggregated data contributes to reduce inequities in freshwater management
5. Informs water policies and facilitates transboundary cooperation in aquifer governance.

Introduction and objectives
Gender analysis and its resulting sex-disaggregated water data play a critical role to ensure SDG achievement, and interconnect targets and indicators particularly for Goals 5, 6 and 15. Concrete ideas for operationalizing SDG targets on gender and water at the project level will be discussed through the use of case studies, such as the SDC-UNESCO GGRETA Project that conducted gender surveys in the Stampriet transboundary aquifer in Southern Africa, and the GEF WWF MAR2R Project focused on the integrated ridge to reef management of the Mesoamerican Reef Eco-Region.

Methodology approach
The GGRETA Project applied UNESCO-WWAP Toolkit (the methodology on sex-disaggregated water data collection and the gender-sensitive priority indicators) in intra-household (HH) surveys in Botswana and Namibia, to investigate gender roles and decision-making in water access and use. Statistical analysis was applied to understand gender relations and whether conditions of gender equality exist in freshwater provision, allocation, and ecosystems conservation. In WWF MAR2R Project, gender analysis is applied at the conception of the water-management project to identify gaps, opportunities and entry points for gender mainstreaming. The project includes gender-responsive activities, as well as gender-responsive implementation, monitoring and evaluation.

Analysis and results
Respondents of the GGRETA Project gender surveys indicate that women are primarily responsible for domestic use of water resources. Water allocation in agriculture and for livestock is instead broadly under men’s responsibility. National water policies have been critically analyzed in light of the results of the sex-disaggregated data gathered in the field. MAR2R project demonstrates how to contribute to the conservation and sustainable use of shared freshwater, coastal and marine resources by addressing gender at all phases of the project cycle. It shows how traditional knowledge can contribute to sustainable development and enhance water ecosystems preservation and functioning.
Conclusions and recommendation
UNESCO-WWAP gender surveys identified socially-determined differences in women and men’s roles, confirming the prevalent role of women in managing freshwater within the household boundaries, and men’s decision-making in freshwater productive uses. Results from the surveys can inform Botswana and Namibia water policies, contributing to gender transformative national and regional actions. WWF-MAR2R project indicates that well-designed projects help ensure women’s access to sustainable sources of safe water and sanitation, and their effective participation in decision-making. Both case studies demonstrate how gender-responsive activities can help moving forward the progress on SDGs, while having significant implications on the protection and restoration of water-related ecosystems.
What gets measured (by women), gets managed

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Keywords
Community-based natural resource management, citizen monitoring, gender, ecosystem conservation, co-creation of knowledge

Highlights
• Many women perceive governance committees and stakeholder consultation meetings as unproductive ‘talk-shops’ with little relevance to their lives
• Citizen science is emerging as an innovative tool enabling local ownership of monitoring processes
• Co-designing monitoring schemes with local women captures their distinctive perception of what should be measured and thus, managed

Introduction and objectives
The gendered nature of water is well documented. In sub-Saharan Africa, rivers, lakes and wetland ecosystems provide key resources for women in poor communities, and women are disproportionately affected by ecosystem pollution, degradation and the loss of informal use rights through wetlands conversion. The impacts of weak resource management on female equity and lack of female engagement in decision making are widely assumed to sustain and perpetuate each other. In this context, citizen science is emerging as an innovative tool for locally relevant monitoring schemes that allow female ownership of monitoring processes and can transform power relationships in resource management.

Methodology approach
The research presents experience of two projects in Zambia, Tanzania and Uganda, promoting local - and in some cases specifically female - leadership in the management of local water resources and ecosystems. An Action Research approach both stimulates and reflects on the development of women as agents of change. Interventions are co-designed with rural women and communities in interaction moments that foster active learning for both researchers and community members. Knowledge exchange in regional networks of communities, partners and experts distills lessons on how involvement of women in citizen monitoring of water resources can improve sustainability.

Analysis and results
Local communities proved highly knowledgeable about the declining productivity of soils and ecosystems, and aware what practices contribute to the problem. However, a legacy of broken promises by projects and agencies, as well as abuses of power by conservation agents create widespread cynicism and mistrust that undermines the work of local (environmental) action groups. Women in particular perceive governance committees and stakeholder consultation meetings as unproductive ‘talk-shops’ with little relevance to their lives. Female representatives ran for election only after ‘practical’ skills trainings, for example in conservation agriculture, revealed the links between resource management decisions and landscape productivity. In this, the findings support a close connection between community access to natural resources (SDG target 1.4), women’s participation in decision-making (5.5) and the conservation of ecosystems (6.6/15.1).

Based on interim findings, current efforts focus on co-designing monitoring schemes with local women and communities, capturing their distinctive perception of what should be measured (and thus, managed). As
key objective, one local community aims to create a platform that forces donors and government departments to talk to each other, before the community is confronted with yet another parochial, redundant or contradictory plan, or request for consultation after key parameters have already been decided.

**Conclusions and recommendation**

Engaging women in local citizen monitoring serves to ensure that resources affecting their livelihoods and wellbeing are monitored, and helps identify and communicate their specific perception of problems and solutions. To be effective, the design process has to give local communities control over decisions on all aspects of the monitoring scheme, starting with its purpose. Key challenges result from the dilemma that donor-funded schemes can enforce participation of women but not ‘create’ agency, and the paradox that gendered approaches to ecosystem management implicitly conceptualize empowerment as a means to a (different) end.
Women, SDGs and climate related adaptation: A Practitioner Perspective

Presenting: Ms. Kusum Athukorala, Women for water Partnership, Sri Lanka
Author:

Keywords
Women, climate, resilience, policy, information

Highlights
- Climate change adaption awareness for rural women affected by droughts through site specific ground level citizen
- Ground level programs challenged by lack of gender desegregated data and gender sensitive initiatives
- Promotion of gender sensitive SDG policy

Introduction and objectives
In the past three years Sri Lanka witnessed a series of multiple and parallel extreme climate related events, literally becoming as a living laboratory for disasters with droughts in the North, floods in the South and landslides in between. Disaster risk reduction in Sri Lanka is generally seen as the responsibility of state agencies. But a partnership of civil society and private sector can address gaps in climate change adaptation through strategic development interventions, thereby strengthening the resilience of communities, especially for women who tend to be marginalized due to inadequate data.

Methodology approach
Inspite of high development indices women in Sri Lanka have had a low political participation, suffer from poor access to information and decision making related to NRM mainly due to insufficient gender desegregated data which would highlight their situation and needs. In trying to support communities who need to move from a dependence on a post disaster response to risk reduction, NetW water with partners from state, civil society and private sectors carried out a series of ground level programs focused on building resilience through information, capacity building and adaptation of community wisdom.

Analysis and results
In the Jalavahini interactive training programmes on climate change adaptation carried out across drought stricken communities for women with hands-on roles at the grassroots level in the water sector, the lack of access to state agencies extension was seen as a major challenge. Citizen science programs carried out in post Samasara landslide in Aranayake saw that communities both men and women were helpless in the face of illicit logging posing a threat to the ecosystem and heightening the threat of future landslides. However policy level initiatives were lacking in a gendered approach which took local realities, issues and knowledge into consideration. It was seen that global documentation related to gender and climate change were inadequate and did not support the national need to push for gender desegregated data a women led collective initiative reviewing the climate related challenges, including the documentation at global level was undertaken in December 2017 by women organizations and women water professionals from all sectors supported by the Sri Lanka Water Partnership. The output of this activity includes a Right to Information (RTI) petition and and the development of a shadow document highlighting ground realities faced by women in Sri Lanka.
Conclusions and recommendation

In promoting successful SDGs related to women ecosystems conservation and climate change, there is a need to strengthen this platform to support a true reflection of ground realities in development, harness local knowledge especially related to climate change adaptation and focus on felt needs of communities especially women. It is also necessary in the view of current funding shortages that advocacy collectives including partners from all sectors, especially the private sector link up with supporting the state. The stage agencies need to be more proactive in supporting gender desegregated data collection.
Seminar: IWRM and ecosystem based approaches: Complementary, duplicating or competing?

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Water, ecosystems and human development
Seminar: IWRM and ecosystem based approaches: Complementary, duplicating or competing?

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Assessing the effectiveness of water policy and governance in Brazil

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Keywords
Governance, Brazil, Observatory, OGA

Highlights
• To share the experience of building the 'Water Governance Observatory' in Brazil;
• To point out its potential contribution to the improvement of the Brazilian National System of Water Resources Management;
• To highlight the lessons learned and the challenges to the sustainability of this platform

Introduction and objectives
Governance has been described as a multi-layered, multi-scale, and multi-sector ensemble characterised by a combination of hierarchical structures, participatory dynamics, associative action, and market mechanisms (Castro, 2007). The existence (and appropriate functioning) of arrangements aimed at ensuring the shared and sustainable management of water resources is directly associated with better protection of freshwater ecosystems. In this context, the report outlines the process of building a national and independent water governance observatory in Brazil (the ‘Water Governance Observatory’), an evidence-based, participatory platform for continuous, independent assessment of the effectiveness of water governance in Brazil, with more than 80 institutions signatories.

Methodology approach
Considering that all the authors are directly involved in the process, representing institutions that have supported the OGA since its inception, the methodological approach can be characterized as ‘Participant Observation’. The purpose is - from this inner vision - to share the experience of building the 'Water Governance Observatory' in Brazil, pointing out its potential contribution to the improvement of the Brazilian National System of Water Resources Management, promoting a critical reflection on the lessons learned and the challenges to the sustainability of this platform.

Analysis and results
A national Water Governance Observatory was first thought of in 2004, under the leadership of WWF-Brazil, which conducted studies and technical meetings, included a short publication evaluating the ‘achievements and challenges’ from the first eight years of the policy. This report also identified and discussed a series of 32 potential indicators. In 2012, after a period of dormancy, it was decided that this issue should be tackled again as there was little sign from the federal or state governments of progress with the National Water Resources Management System (SINGREH). In a partnership with Fundação Getúlio Vargas a study was conducted applying their systematic approach and associated indicators to evaluate SINGREH. This took one year, including extensive background research, stakeholder interviews and the convening of two expert workshops. It resulted in a 2014 report: Governance of Water Resources – Proposal of indicators to monitor implementation. As a consequence of this process, by November 2015 the concept of an observatory had generated great interest throughout the country, with over 50 key institutions engaged in the observatory. By the end of 2017 more than 80 institutions were already engaged in the observatory, including federal and state water basin committees and forums.
Conclusions and recommendation
Brazil has made remarkable progress in water resource management, based on a decentralized, participatory and integrated system. However, multi-level governance is particularly critical in a federation, and rooted in a recent history of participatory democracy (OCDE 2015). Therefore, despite the progress achieved, the management of SINGREH still needs to be consolidated in order for it to be effective (WWF, 2016). We defend that the ‘Water Governance Observatory’ can be an important tool to provide the transparency required to enable Brazil to move towards responsible management and guarantee sustainable access to water for its citizens, economic activities and for natural ecosystems.
Assessing the interconnectedness of ecosystems, water and food

Presenting Author: Prof. Nicola Fohrer, Global Water Partnership, the German Hydrological Society, Germany

Keywords ecosystem services, ecohydrological modelling, assessment of interconnectedness

Highlights

Three showcases of an integrated assessment of water related ecosystem services in complex multifunctional river basins in China and Siberia are presented. Ecohydrological and ecohydraulic model chains were used to analyse impacts of land use and climate change on water resources, aquatic biodiversity and water-related ecosystem services

Introduction and objectives

Typically, river basins are clearly multi-functional, providing various types of ecosystem services affecting virtually every aspect of life. Water resources and ecosystems in particular are under pressure, being affected by multiple stressors and all dimensions of global change. To understand and ultimately manage these relations and the interaction of key drivers, landscape processes and feedback mechanisms, an integrated and interdisciplinary modelling approach in accordance with the principles of IWRM is required. The objective of this study is to assess the interconnectedness of ecosystems, water, energy and food and where possible to quantify impacts of IWRM on water-related ecosystem services

Methodology approach

For all three case studies an ecohydrological/hydraulic modelling change has been established applying the SWAT model on catchment scale and the HECRAS model for instream processes. Changes of land use (induced by hydropower dams or agricultural intensification) have been detected using field surveys, farmer interviews and remote sensing. Aquatic biodiversity was assessed with field surveys and the implementation of species distribution models. Impacts of climate and land use change on water resources have been quantified with the modelling chain and the impact on water related ecosystem services as well as on biodiversity have been analyzed.

Analysis and results

Case 1: Three Gorges Dam

The resulting land-use changes, due to resettlement of lost agricultural land and urban areas, potentially could increase erosion and landslides in the catchment, which would imply a high risk of eutrophication in the reservoir. The results of these model runs, however, show that cropland was partly converted to forest and orange orchards, showing a move from home self-subsistence to market fruits. As a result, the sediment yield was, contrary to expectations, clearly reduced.

Case 2: Chiangjiang River

This integrated approach enabled a joined hydrobiological and hydrological assessment. The assessment demonstrated how the spatio-temporal variations in hydraulic variables shape the distribution of key species (grazers and filter feeders) in this river system.

Case 3: Northern Siberian Lowlands

The main question posed here was, what would happen to ecosystem services (provisioning, regulating, cultural) if projected temperature increase affects snow melt, the key hydrological driver in this area. The interdisciplinary methodological framework resulted in an indicator-based assessment of several ecosystem services. It revealed that water flow regulation is the key service in this landscape, because water flow is the dominating/limiting factor for agriculture.
Conclusions and recommendation

In conclusion, with regard to the interconnectedness of water, food, and biodiversity the impact of land-use change/climate change on water balance components is relatively well understood, despite data scarcity or non-stationarity. Progress has been made in linking hydrology and hydraulics to model aquatic biodiversity as a function of global change. It has also been made in depicting spatially and temporally distributed ecosystem services. However, more research is still required when it comes to considering multiple landscape functions/services for multi-goal optimization (e.g., agricultural yield, water quantity and quality, biodiversity, income) as a stakeholder driven process.
Can you sue a river? Legal rights and IWRM

Presenting Author: Dr. Erin O’Donnell, University of Melbourne, University of Melbourne, Australia
Co-Authors: Dr. Avril Horne, University of Melbourne, Australia

Keywords
legal rights, IWRM, competition, collaboration, river

Highlights
In 2017, rivers in New Zealand, India, and Colombia were granted the status of ‘legal persons’ to protect their ecosystems. Reactions to the new ecosystem-based legal rights for rivers show that creating separate, legally enforceable rights for aquatic ecosystems can increase competition between water users and weaken IWRM.

Introduction and objectives
In 2017, rivers in New Zealand, India, and Colombia were granted the status of ‘legal persons’, and now have the right to enter contracts, to own property, and to sue and be sued in court to protect their ecosystems. Although these specific legal rights remain highly novel, the concept of creating legal rights to water for the environment (including rivers, wetlands, groundwater systems, and estuaries) is widely accepted. However, the reaction to the new ecosystem-based legal rights for rivers shows that creating separate, legally enforceable rights to water for the environment can undermine the goals of IWRM.

Methodology approach
This presentation examines the creation of legal rights for rivers in three countries (New Zealand, India, and Colombia) from the perspective of IWRM. Data is presented on: (1) the method of creating the new legal rights; (2) aims and objectives of the legal rights; (3) institutional settings, organizational capacity and funding for the entities now considered to be the ‘voice’ of the river; and (4) reactions from the media and local governments on the implementation of the new legal rights, including the willingness to manage the rivers under an IWRM framework.

Analysis and results
Reactions to the new legal rights for rivers have been telling. In New Zealand, farmers within the catchment of the Whanganui River are concerned that the rights of the river may interfere with their ability to farm. In India, the state government guardian was so concerned that it could be held responsible (and sued) for the future flooding of the Ganges River that it appealed the decision to the Indian Supreme Court. When placed in the context of water resource management, these examples demonstrate the challenge of establishing adequate legal protections for aquatic ecosystems, without creating an adversarial, competitive relationship between the environment and other water users.

Effective IWRM requires different water users to work together to achieve shared benefits, particularly when water is scarce. However, private rights based systems for managing water and the environment often drive the creation of new legal rights to water for ecosystems. These legal rights can lead to better environmental protection, but they also reduce the willingness of other water users to collaborate and achieve multiple outcomes. Worse, there is a growing fear that people affected by the ‘actions’ of a river (such as flooding) will seek to sue the river for damages.

Conclusions and recommendation
Rivers and other aquatic ecosystems are increasingly being granted legal rights, including rights to water as well as the rights of a legal person. These rights are lauded as increasing legal protection for aquatic ecosystems, but more thought needs to be given to how these new rights can operate with IWRM frameworks. At present, there is a real risk that legal rights will increase competition with other water users, and undermine collaboration between water users and across water sectors.
Coastal flood adaptation for indigenous communities in Canada

Presenting Author: Mr. Andrew Robinson, Nisga First Nation, Canada
Co-Authors: Mr. Dave Murray, Canadian Water Resources Association, Canada

Keywords
Indigenous, Coastal Flooding, Climate Change Adaptation, Cultural Values

Highlights
First Nations in the North American continent region are working to overcome conflicts over water management. The Canadian Water Resources Association (CWRA) a network of water professionals across Canada has formed an Indigenous Water Issues Committee to provide focus on First Nations challenges such repeated flooding from coastal inundation.

Introduction and objectives
Future predicted flood levels due to sea level rise will further impact already problematic flooding in coastal First Nations communities. This presentation will overview the challenges to First Nations from increasing coastal flooding. First Nations traditional knowledge is abundant yet rarely integrated into the Integrated Water Resources Management approach which incorporates flood impacts with environmental and social aspects of water management. First Nations in coastal BC are beginning to study the future impacts of climate change on their communities and are now developing adaptation plans that consider their relationship with water and how traditional knowledge and values can be considered.

Methodology approach
Working with First Nations Communities and Canada’s Federal Government, CWRA’s Indigenous Water Issues Committee acts to facilitate understanding of coastal adaptation issues due to climate change. The committee discusses shared water concerns and responsibilities and assist to incorporate traditional knowledge, relationship to water and environmental issues into integrated flood adaptation planning. The committee engages First Nations and facilitates a transfer of information and input from our network of water professionals, and provides assistance to enhance internal capacity. The CWRA Indigenous Water Committee acts as a facilitator in this process.

Analysis and results
CWRA’s committee provided oversight of a conference session which facilitated sharing of results of adaptation planning and shared challenges. This built better understanding of First Nations coastal flooding challenges, their relationship to traditional knowledge and values such as connection to water. This undertaking built First Nations professional capacity to present project findings in an open forum. This resulted in a greater integration of First Nations water issues into CWRA’s conference and resulted in a This sectoral conflict between First Nations and other communities can result in increased flood risk to coastal First Nations communities. Results indicate that integration of First Nations traditional values can enhance ecosystem function, establish interlinkages in the planning process and result in better more comprehensive values moving toward the values of UNDRIP.

Conclusions and recommendation
Conclusions are that First Nations within the Canadian region are more vulnerable to climate change than other non-indigenous communities due to lack of funding, community professional capacity and understanding of flood risk. With the consequences to flooding increasing as sea level rises, so will the risk to First Nations. Integration of cultural values and knowledge into IWRM planning has provided an opportunity for CWRA promote more effective Indigenous water management.
Effective stakeholder participation in IWRM and ecosystems approach

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Keywords
Stakeholder, Sustainability, Permaculture, Ecosystems, Community

Highlights
In 2012, Water For People partnered with Strathclyde University to implement an Integrated Water Resources Management (IWRM) approach in the Traditional Authority Chapananga in Chikwawa-Malawi. The goal was to maximize economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems.

Introduction and objectives
In 2016 a research study was initiated to evaluate the work that has been carried out between 2012 and 2016 in respect to localised IWRM in Chikwawa district of Malawi. The research assessed the impact of localized IWRM on functionality of water points and the incentives for stakeholder participation. IWRM recognizes the economic benefits of managing water and related resources in an integrated manner. Well-managed water and other natural resources provide high levels of Ecosystems. Ecosystems valuation and management is a practical way of achieving IWRM goals as well as other tangential socio-economic and environmental benefits.

Methodology approach
The research was carried out in 115 villages in Traditional Authority Chapananga- Chikwawa. This is the area where the localized IWRM project was implemented in 18 villages, hence the 115 villages included both non-intervention villages. Water point mapping and service provider interviews were conducted.

Specific Objective
• Assess if there is a relationship between practicing IWRM principles and functionality of water points (a water point is both a resource and habitat for ecosystems).

Research Questions
• Is there is a relationship between adopting IWRM principles and functionality of water points?

Analysis and results
Assess if there is a relationship between adoption of IWRM principles and functionality of water points To find out whether communities adopted IWRM principles we looked at the following indicators: (1) High Stakeholder participation – community confidence and competence to create financial and social value around the water supply system beyond merely providing clean water, especially in women. (2) Permaculture - Development of gardens to use excess borehole water and local resources to grow crops, which generates income with the understanding that water is a finite resource and for sustainability of the (3) Water Point Banking – Establishment of tariff structure to recover full costs and be converted to savings, which can be loaned out at an agreed interest rate to the users, further building financial capital for pump management. This links to the understanding that water is both a social and economic good. Results In our sample of 115 villages, 100 % of the water points (41/41 water points) where the villages adopted IWRM principles had their water points functional, this is much better than the non IWRM adopters (64.9% functional) or national figures where 25% of water points are nonfunctional at any given point (Joint Sector Performance Report, 2014).
Conclusions and recommendation
It can be concluded that there is a relationship between practicing IWRM and ecosystems approaches and functionality of water points/resources. Where IWRM and Ecosystems approaches are integrated, there is high probability that the water resource would be sustainable as it also plays as a habitat for ecosystems.
Environmental paradigm and water management at Lujan River Basin in Argentina

Presenting Author: Dr. Mariano Ferro, University of Buenos Aires, Argentina
Co-Authors: Dr. Clara Minaverry, National Counsel for Scientific and Technical Research and University of Lujan, Argentina

Keywords
Lujan River Basin, Ecosystem Approach, Ecosystem services, Water Management Fragmentation, Integral Management of the Water Resources.

Highlights
This paper contributes to:
1. The evaluation of the effectiveness of legal-institutional mechanisms which are influenced by two interrelated approaches: the IWRM and the Ecosystem Approach,
2. To analyze ecosystem services valuations at Lujan River Basin, Argentina, and
3. To analyze the effectiveness of class actions in connection with water affectation.

Introduction and objectives
Pollution in the metropolitan basins of Greater Buenos Aires is the most important urban environmental problem in Argentina, and one of the most serious in the world. However, since the 1990’s there have been important progresses in the institutionalization of the environmental paradigm.
In this paper we analyze the level of effectiveness of these institutional advances, in connection with the application of two fundamental and interrelated approaches, for the implementation of the environmental paradigm, the IWRM and the ecosystem approach, in one of the metropolitan basins of Greater Buenos Aires: Lujan River Basin.

Methodology approach
A qualitative research was adopted, according to R. Ying’s case analysis method (2004) and the strategy of methodological triangulation: conducting interviews with experts and key informants; legal and jurisprudential analysis of ecosystem services, of public documents and of national newspapers.
All the rules are examined at the municipal, provincial and national levels applicable to the Lujan River Basin, and all argentine court rulings referred to this case study. The methodology of legal hermeneutics was used for jurisprudential and normative analysis.

Analysis and results
The extremely complex legal-institutional context, which was conditioned by the fragmentation and normative overlap, the almost absence of the ecosystem approach in politics and law in the Province of Buenos Aires, the insufficiency of scientific knowledge or the use of the available, the lack of sufficient mechanisms of citizen participation, diagnosis and integrated management plans, the lack of procedural regulation of collective actions in environmental matters in Argentina, and the avoidance of environmental responsibilities by different players, constitute substantial obstacles for the implementation of the environmental paradigm in the Lujan River basin.
We highlight a series of consequences of the aforementioned obstacles for the application of the environmental paradigm to our case study: the serious risk of one of the most biodiverse ecosystem, and with unique characteristics in the world: the Delta of the River of Plata, causing the increase of occurrence of floods; the deterioration of the archaeological and cultural heritage; causing adverse socio-environmental effects, including the lack of substantiation of environmental rights and obstructing access to drinking water and environmental sanitation of coastal populations.
Conclusions and recommendation
The empirical and bibliographic-documentary evidence analyzed shows that water policies at the level of the basin, in our case study, are deficient and have low standards of effectiveness, while policies focused around ecosystems are practically absent. We conclude that there is a need of coordination between the various jurisdictions, including the international one, as well as the conjunction between the management of river basin and of the ecosystems.
Finally, we highlight an urgent need to incorporate the role of ecosystems recognized by the Millennium Ecosystem Assessment in water policies in Argentina.
IWRM and ecosystem, the gap between theory and application

Keywords
IWRM, Ecosystem, River Basin Management, Jordan Valley, Sustainable Management

Highlights
This paper presents the gap between theory and application in IWRM and Ecosystem management approaches. The ecosystem should be considered as an essential element in the IWRM and not duplication. However, the main issue here is not the in the concepts but rather in the application.

Introduction and objectives
According to GWP IWRM main objective is to maximize the economic and social welfare from the development and management of water, in an equitable manner without compromising the sustainability of vital ecosystems. The sustainability of ecosystem is an outcome or result from the IWRM. In other words, the IWRM form the strategies and actions to protect the ecosystem. This make it clear that there is no competition or duplication between IWRM and Ecosystem. The problem here is not in the IWRM and Ecosystem concepts but rather in the application part where the IWRM plans do not consider the ecosystem elements.

Methodology approach
The paper analyzed IWRM for several case-studies, the analysis includes IWRM objectives, elements and outcomes. The analysis show that a clear lack of focus on ecosystem services and a stronger focus on more conventional services. Those cases demonstrate a lack of integrated approach where all elements of ecosystem are considered including other issues such as transboundary dimension, soil, animals, plants, food production, water storage and flood prevention. This shows the gap is in the IWRM integration and implementation rather than concepts. The IWRM for Jordan River Basin is used to demonstrate the gap.

Analysis and results
The Ministry of Water and Irrigation (MWI) in Jordan had developed IWRM for the Jordan River basin. The system focus was on how to increase the water availability and water quality in the catchment area of the Jordan Valley without endanger vital ecosystems and social and economic conditions. Going through the IWRM it aimed at (1) minimize quality degradation and maximize efficiency of water resources (2) Consider and evaluate specific social, economical and ecologic conditions and impacts of water resource development options; (3) Identify the benefit and applicability of alternative technologies for sustainable water usage (4) Increase the understanding of the hydrological system. As shown above the goals covered only part of the ecosystem elements (water, quality, ecological conditions, impact of water resources development, sustainable water usage). Other elements such as soil, climate, animals, biodiversity, floods protection were not covered. There is a gap in integrating all elements for different reasons such as level of importance (the water usually comes as high priority in any study area while others less so in most IWRM are ignored. This proofs that the gap is in the IWRM integration and implementation rather than concepts itself.
Conclusions and recommendation

Ecosystem is an essential part of the IWRM and not duplication. The integrated approach for incorporating ecosystems into IWRM would produce new benefit opportunities such as;

- Biodiversity benefits and increased resilience to extreme climate events such as floods and droughts, which would complement more traditional benefits such as hydropower and navigation.
- It covers an essential part related to compensations of resulted damage or impact in the failure of services related to any element of ecosystem.
- It encourages incentives and markets for managing and providing healthy and sustainable ecosystems, and addressing drivers of ecosystem change more systematically.
Participatory ecosystem management as decentralised IWRM: Lessons from India

Presenting Author: Dr. Nandita Singh, Water Development Centre (UCV), Norrtälje, Sweden
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Keywords
Participatory ecosystem management, water conservation, decentralised IWRM, India, community participation

Highlights
This presentation will highlight the complementarities between ecosystem-based approaches and IWRM. It will discuss how participatory ecosystem management at the local scale reinforces IWRM which ultimately enables water security and balances water use between people, food production and environment, presenting successful case studies from India.

Introduction and objectives
Ecosystems and water resources are closely intertwined but ignorance of this delicate relationship and mismanagement of ecosystems for obtaining narrow and short-term economic gains has ultimately led to water insecurity in many parts of India. However, the mistakes have been identified in some areas at the local scale and community-based efforts are under way to implement sustainable solutions by restoring the over-exploited ecosystems. What is the nature of these participatory ecosystem management approaches? What outputs have these efforts delivered in terms of IWRM? This presentation aims to answer the above questions, illustrating successful case studies from different parts of India.

Methodology approach
The presentation is based on the findings of an empirical research in arid/semiarid India funded by Vetenskapsrådet. Data was collected through qualitative research methods in selected villages in states of Rajasthan, Bihar and Maharashtra. The study was based on the framework of IWRM, conceptualized as an approach promoting coordinated restoration and management of water, forest and other natural resources, with the aim to maximize equitable social welfare together with ecosystems sustainability. ‘Integration’ primarily focused on: green and blue waters and the water cycle, different water use sectors, and that of all stakeholders in planning and action.

Analysis and results
The study revealed that ecosystem degradation in the study villages was a result of overexploitation of natural resources, notably water, forest and pastures. Consequently, ecosystem restoration process, which was initiated with community participation, had 3 main components, namely, water conservation, afforestation and rejuvenation of pasturaleands. Both women and men participated in the process and over time the effects became visible, with higher water availability. The water conservation was carried out differently in different econiches. Watershed structures like checkdams, anicuts, water absorption trenches and gabions were constructed to slow down the flow of water as well as help retention of soil moisture and groundwater recharge. Simultaneously, the lost vegetation has been replanted, and the forest trees as well greenery in the pastures so restored has been protected through community management rules. These efforts have rejuvenated lost rivers and ponds, recharged groundwater and enhanced green water content in soil, restoring the flora and fauna. In turn, these actions have revived agriculture, provided safe drinking water, enhanced crop and animal productivity, thereby preventing migration and fighting poverty. In the end, many such villages could come back to the path of sustainable development.
Conclusions and recommendation
The study has presented complementarities between approaches of participatory ecosystem management and IWRM at micro-watershed scale in India, illustrating how the former has helped reinforce what can be called ‘decentralized IWRM’. The complementarities between the two approaches primarily constitute ‘integration’ of: green and blue waters, and different water use sectors, and active participation of all stakeholders in planning and action, ultimately bringing forth water sustainability. Given its success at the local scale, it can be argued that replication of the approach in neighboring degraded micro-watersheds can lead to achieving IWRM at progressively higher scales within and between river basins.
Reducing uncertainty in ecosystem based approaches towards more holistic IWRM

Presenting: Dr. Mary Matthews, United Nations Development Programme
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Keywords
IWRM, Environmental Flows, Kura Basin, Ecosystem-based approach

Highlights
This paper examines both IWRM and ecosystem based approaches through the lens of a collective action problem, where uncertainty and player needs identification provides clarification of the challenges of implementations for both approaches. The implementation of environmental flows in the Kura basin will serve as the case study.

Introduction and objectives
IWRM Application is often based on a model of water resource distribution rights similar to those of any classic ‘tragedy of the commons’ scenario in which excessive use of a limited resource at a particular time degrades the availability of the resource to other users. The ecosystem-based approach expands the user pool to wider and less well-defined users and interests, creating uncertainty. The question then emerges how to deal with the inherent uncertainty in the ecosystem-based approach to more effectively implement a more-holistic IWRM with balanced demands for all sectors and actors applied with pareto-optimal outcomes in the Kura Basin.

Methodology approach
The methodological approach of this paper relies on examining how to apply IWRM and ecosystem-based approaches to staged environmental flow methodologies in the case of Kura River sub-basins. Using collective action and common property management approaches to examination incentive structures of IWRM and ecosystem-based approaches through the case study of application of increasingly complex staged environmental flow methodologies.
The case studies emerge from the UNDP-GEF Kura II Project: Implementing IWRM Across the Kura River Basin, which will test these approaches within the framework of this project, using both the environmental flow staged approaches and collective action for common-pool resource management.

Analysis and results
This paper explores the economic trade-offs and institutionalized rules of the game for ‘traditional’ IWRM, for the ‘ecosystem-based approach’, and how to interlink these to increase long term sustainability of water resources using staged environmental flow management scenarios found in the Kura River basin. Traditional IWRM relies on principals of common pool resource management with relatively clear data driven demand forecasts, all players as user sectors, are given voice are apportioned user rights. The ecosystem-based approach includes wider societal uses and ecosystem services and needs that are less easily measured, introducing a higher level of uncertainty for all players. This uncertainty contributes to resource guarding among sectors and increases incentives for free riding.
The case studies will highlight existing and planned management practices designed to equitably allocate water resources across sectors in current and planned development schemes for improved sustainability, that emphasises not only the downstream social and ecosystem demands but also the upstream contributions that must be fostered to ensure pareto-optimal outcomes.
Technical environmental flow management approaches will be presented in the partner paper ‘Staged approaches for implementing environmental flows to maximize wider social and ecological benefits in the Kura River Basin’ by Ahmed Abou Elseoud et. al.

Conclusions and recommendation
The preliminary conclusion of this ongoing study is that application of a traditional IWRM approach to water management for environmental flows in the Kura basin can be an effective starting point for bringing multiple sectors together to understand the critical need for integration. The application of data rich approaches increases trust and decreases free-riding. However, a more data intensive and often less concrete ecosystem-based approach is needed to ensure the contribution of ecosystem services to water management in order to sustainably manage water resources over the long term and account for climatic uncertainty. This recommends staging IWRM with ecosystem-based approaches.
SDG targets and implementation of IWRM in Sri Lanka

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Co-Authors: Dr. Prabash Ganeshamoorthy, University Of Colombo, Sri Lanka

Keywords
ecosystem approach, water management, conservation, assessment, governance

Highlights
• The sustainable development plan targets and potential implementation of IWRM in Sri Lanka
• How to bridge the gaps between national plans and SDG
• IWRM and good water and ecosystem approaches is an asset for growth in the economic, social and environmental sectors in Sri Lanka.

Introduction and objectives
The ecosystem approach to water management, is a complementary to IWRM, that adopted as SDG 6 dealing with the complex task of securing and balancing water for all human needs. But the dependency of human well-being on ecosystems has been given insufficient attention. Experience with the SDG’s has shown that conventional governance approaches have only inadequately addressed this challenge. This paper discusses how cross-sectorial linkages and multi-stakeholder water stewardship and good governance based on comprehensive policies combining the strengths of the private sector and civil society provides for a significant increase in ecosystem-sensitive development in Sri Lanka.

Methodology approach
The research paper adopts a comparative case study methodology of two upstream and coastal ecosystems in Walawe Basin of Sri Lanka, how they manage conservation, restoration and sustainable use of inland freshwater ecosystems and their services. The participatory approach was used mixing qualitative and quantitative methods including: a household survey; group discussions, participation of local stakeholders and politicians were used to bridge the gaps between the current sustainable plans and SDG’s. The multi-criteria analysis tools, complementing IWRM was used on a proper assessment of environmental and social ecosystem cost and benefits, securing and balancing water for people.

Analysis and results
Statistical analysis of the household surveys reveals that lack of cross-sectoral linkages leads to uncoordinated water resource development and management, resulting in conflict, waste and unsustainable ecosystems hindering large scale deforestation and denudation of green cover. The study showed that the new government has developed multi-functioning ecosystem-sensitive development plans linked with better alignment and combination of policies laws and regulations with some incentives and innovating financing to restore, protect, use and manage their environment complementing IWRM approach. It coordinated harmonically all stakeholders including politicians at micro-watershed level to work towards breaking the cycle of ecosystem degradation and loss. Result shows that 19% increased in new forest cover. The new innovative systems like circular economy to reuse and recycling of wastewater and sludge handling strategies at Rice Mills and Sugar Factories, highlights energy saving and water purity systems, where research shows that the economic return spending is US $ 7.50 per US dollar invested. Infrastructure investments provides to affects coastal zone ecosystems, to prevent and reduce marine pollution, including design of Salinity Barrier and Wetland that will treat municipal waste and prevent saline intrusion, targeting saving over 759 million annually managing environmental and social ecosystem by complementing IWRM.
Conclusions and recommendation
The study proposes IWRM and ecosystem based approaches is a complementary for addressing ecosystems degradation and the maintenance of ecosystem services. This systematic process can be applied to any other vulnerable ecosystems. This should be based on cross-sectoral linkages and multi-stakeholder water stewardship and good governance combining with interrelated multi-functioning plans linked with combination of policies laws and regulations. Which should provide incentives and innovating financing for a significant increase in ecosystem-sensitive development complementing IWRM approach. If implemented at a large scale, this can provide opportunity to work towards achieving multiple SDG targets.
Seminar: Political drivers for sustainable ecosystems

ABSTRACT VOLUME

World Water Week 26 - 31 August 2018

Water, ecosystems and human development
# Seminar: Political drivers for sustainable ecosystems

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A multinational commitment to save the world’s largest tropical wetland

Presenting: Mr. Marcelo Cruz, Brazilian National Water Agency, Brazil
Author: Mr. Sérgio Ayirimoraes, Brazilian National Water Agency, Brazil

Keywords: wetlands, governance, transboundary, conservation, sustainable development

Highlights
The Pantanal is key for biodiversity, with South America’s highest concentration of fauna.
It is key for development: Pantanal states contribute more than $70 billion to their national economies.
The Pantanal Challenge offers an innovative model for cooperative transboundary water management to achieve policy priorities, including Sustainable Development Goals

Introduction and objectives
The Pantanal Challenge is the first transboundary initiative to sustainably develop and conserve the world’s largest wetland, shared between Paraguay, Bolivia, and Brazil. The Pantanal is one of the most biodiverse places on the planet and a major contributor to the economies of the three countries. Yet, this region confronts significant development pressures which threaten to destabilize this unique ecosystem. Building on dialogues between national governments, civil society, and the Pantanal community, Brazil, Paraguay, and Bolivia will come together at the 2018 World Water Forum to announce a path to jointly sustainably develop and conserve the Pantanal.

Methodology approach
With no transboundary framework for the world’s largest freshwater wetland currently in place, the Pantanal Challenge will fill a major gap in understanding how to manage a freshwater ecosystem for economic growth and biodiversity conservation. This project entails a partnership between high-level government officials with support from WWF. By engaging in ongoing trinational dialogue, each country will understand how their land uses and policies affect one another and how the collective environmental challenges, specifically climate change, will impact them all. The three countries are committing to design a sustainable, prosperous future for the Pantanal ecosystem and inhabitants.

Analysis and results
Lack of integrated management of the Pantanal has led to the overexploitation of the Pantanal’s resources and unsustainable infrastructure development. The Pantanal Challenge exemplifies a novel approach to transboundary ecosystem management, working across a series of government levels to create a framework for the Pantanal that reflects the socioeconomic concerns of various parties and the needs of biodiversity. With the intended declaration of trinational cooperation for the sustainable development and conservation of the Pantanal planned for the World Water Forum in Brasilia in 2018, Brazil, Paraguay, and Bolivia are setting a precedent for similar efforts aimed at managing major transboundary ecosystems. Successful steps taken thus far include stakeholder engagement and dialogue across local, state and national levels; identification of key ecosystem services and the threats to those services; and strategic actions for improving the Pantanal’s health. This trinational initiative builds upon collaborative, intergovernmental work that is already happening within the five countries that compose the Rio de la Plata Basin in which the Pantanal sits.
Conclusions and recommendation
This project demonstrates forward thinking and proactivity in addressing the insecurity and vulnerability associated with climate change projections for the Rio de la Plata Basin. The flood control benefits of this project extend beyond the Pantanal to include millions of people downstream in Uruguay and Argentina. As the three countries advance the Pantanal Challenge, it will be a model for how to leverage national economic concerns and goals as means to achieve development and conservation goals for a globally important ecosystem.
Cooperation and conflict: A subnational analysis of regions under threat

Presenting Author: Mr. Stefan Döring, Uppsala University, Sweden

Keywords
Water scarcity, violent conflict, cooperation, pollution, large-N

Highlights
The research shows linkages between water scarcity to both conflict and cooperation. Employing a subnational approach provides a more fine-grained perspective. With data on precipitation, groundwater depth, water pollution, the work offers a comprehensive analysis of several factors that are crucial when understanding the links between water and security.

Introduction and objectives
Extreme water shortages have been frequently associated with violent uprising. Yet, some areas witness more cooperative actions when facing droughts or other water deficiencies. This begs the question why some places experiencing water scarcity are more likely to see cooperation around water while others do not. Studying this question, quantitative research (in contrast to case studies) has almost exclusively focused on state- or basin-level comparisons, largely disregarding subnational levels of analyses. This research moves away from country aggregates by using disaggregated data: the work empirically analyzes the association of water scarcity on cooperative events as well as violent conflicts.

Methodology approach
This study captures subnational variation by using geo-referenced event data on water related cooperation as well as violent communal conflict incidences. Using 55 by 55 km grid cells allows for a much more nuanced analysis of available water resources, which also takes into account factors such as agriculture, economic development, ethnic discrimination or prior exposure to violence. With different regression model specifications, the full panel analysis covers Africa, and the Middle East for 1990 to 2016. Some data in this study however require cross-sectional approaches.

Analysis and results
The findings show that the association between water shortages and conflict (or cooperation) are conditional on government type, infrastructure, and economic conditions. In addition, the findings not only suggest that analysis on water scarcity and conflict ought to include measures beyond rainfall data, it also shows that groundwater is an important predictor for conflict when holding other factors constant. Lacking both access to groundwater or experiencing unusually low rainfall is associated with an increased risk of violent communal conflict. Further, groundwater access can be a key adaption tool for areas with less precipitation. What is less clear is how state institutions can mitigate structural issues pertaining to scarcities which makes cooperation on water resources more likely. More results on what explains cooperation and how water pollution affects these findings will be presented during the seminar.
Conclusions and recommendation
Governments are positioned to alleviate water shortages by implementing environmental policies that involve intervention, resource conservation, or redistribution. Such policies are expected to be more effectively utilized in well-administered areas. Yet, this also underlines the importance of non-governmental actors which can significantly support policy efforts. This research identifies not only broader regions that are of higher security concerns; moreover, the work highlights where actions are required within a country. Problems with water allocation are not ubiquitous and demand actions depending on the context. This research enables us to differentiate between different sources of conflict, thereby unpacking some of these complexities.
Linking water ecosystem services and migration in inner Niger delta

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Keywords
wetlands, drought, household, ecosystem services

Highlights
- This study highlights the link between water ecosystem services and migration in Inner Niger Delta;
- It shows that water ecosystem services are the main livelihoods of the people. Water ecosystem services’ decreasing is increasing people migration;
- The migration could be limited through restoration and conservation of ecosystems and biodiversity.

Introduction and objectives
The Inner Niger Delta (IND) is highly productive and biologically diverse ecosystems, fed by seasonal floods. It plays a crucial role in shaping culture and driving local and national economies. Over one million of people composed mainly of fishermen, farmers and breeders depend on the vitality of these wetlands. Despite of the resources that contained the IND, people continue to migrate towards other countries. The main objective of this study is to analyze the link between water ecosystem services and migration in IND. Specific objectives are to value economic ecosystem service for the households and analyze the determinants of migration.

Methodology approach
This study is based on 1200 households’ random survey from 60 villages in IND. The survey was conducted during October to December 2017 in Mopti and Segou regions in Mali. The collected data concerned household socio-demographic characteristics, number of migrants in the households, type and value of water ecosystem services, security issues, willingness to migrate, etc. Descriptive statistics and statistic tests were used for data treatment. The determinants of households’ willingness were analyzed using logistic regression model.

Analysis and results
In IND, the households are composed between 07 and 12 member with 10 members as average. Water ecosystem services are their main sources of food, energy, transport and income. Irrigated and submersion agriculture, fisheries and livestock are the primaries activities of 62%, 21%, 17% respectively of households. For the households, climate change and infrastructure construction (ex: dams construction, irrigated agriculture areas expansion) are sources of the degradation of water ecosystem services. Migration touched 62% of survey households in the villages and 69% of household chiefs/household member willingness to migrate. The determinants of households’ members’ willingness to migrate are food insecurity, lack of fish in the river, lack of fodder for animal, climate change, insecurity, age, education, income and culture.
Conclusions and recommendation
Water ecosystems provide important services to people of Inner Niger Delta but they continue migration in the other countries. The migration’s factors are food insecurity, lack of fish in the river, lack of fodder for animal, climate change, insecurity, age, education, income and culture. To limit migration, it is necessary to restore and conserve water ecosystem by innovations in climate adaptation, integrated water resource management and people sensitization.
Protracted conflict and the targeting of water infrastructure

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Keywords
Water, Sanitation, Infrastructure, War, Ecosystems

Highlights
Protracted conflict is a common feature of war in the Middle East. Here, we examine the impact of repeated cycles of targeting and reconstruction of water and sanitation infrastructures in Palestine, Lebanon, and Iraq, as the destruction of water infrastructure affects human development, economic livelihoods, and ecosystem health.

Introduction and objectives
The targeting of critical environmental infrastructures (i.e., water, energy, and sanitation) by local and external forces is a common feature of new Middle Eastern wars. We examine the impact of repeated cycles of targeting of water and sanitation infrastructures in Palestine, Lebanon, and Iraq. Our analysis of protracted conflict draws upon an original database compiled by the authors and interviews with NGOs, humanitarian actors, and government officials. The repeated destruction and reconstruction of water and sanitation infrastructure, particularly when combined with sanctions regimes and urban sieges, exacerbates civilians’ vulnerability, inhibits investment in basic services, disrupts livelihoods, and affects ecosystem health.

Methodology approach
Our analysis of protracted conflict draws upon an original database compiled by the authors and interviews with NGOs, humanitarian actors, and government officials. Our coding focuses on: (1) type of environmental infrastructure; (2) location and date; (3) actor involved in targeting of infrastructure; (4) intentionality of the actor where known; (5) extent and duration of damage; (6) civilian casualties and other health impacts; and (7) type of ecosystem damage.

Analysis and results
Our research illustrates the failures of international humanitarian law and environmental law (including water law) to deal with protracted conflict. We find that the repeated destruction of water and sanitation infrastructure, particularly when combined with sanctions regimes and urban sieges, exacerbates the vulnerability of civilians, inhibits investment in basic services, disrupts livelihoods, and affects ecosystem health.

Conclusions and recommendation
Our conclusions and recommendations focus on better documentation of what happens to water infrastructure during war and mechanisms for better accountability to ensure implementation of international humanitarian law and environmental (particularly, water) law in protracted conflicts.
Regional master plan for sustainable development in the Jordan Valley

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Keywords
Jordan Valley, Master Plan, National Security, Development, Water

Highlights
- Since launching the Master Plan for Sustainable Development in the Jordan Valley, EcoPeace has been working with the Jordanian, Palestinian and Israeli governments to achieve agreement on a selected list of interventions.
- The plan's objective is to promote peace, prosperity and security in the Jordan Valley and the broader region.

Introduction and objectives
Political conflict has contributed heavily towards the Jordan River's current dire state. The issue is further complicated by the river’s strategic importance as an international border. Rehabilitation is being hindered by the failure of the Israeli, Palestinian and Jordanian governments to agree on other core political issues. Reaching an agreement on rehabilitation of the Jordan River could therefore be viewed as a catalyst for regional integration and security. The Master Plan comprehensively identifies feasible, realistic interventions that could rehabilitate the Jordan River, while providing economic prosperity, greater national security, and progress towards political peacemaking in the region.

Methodology approach
The waters of the Jordan River were first diverted by Israel, Syria and Jordan in the 1950s, leaving less than 5% of its historic flow of 1.3 billion cubic meters in the river today. The opportunity to launch a regional integrated development approach, led by water security issues, is in fact further strengthened when one considers the broader political instability in the region. The Master Plan delivers a projection of population and economic figures for the years 2025 and 2050 and related land and water requirements, while identifying major challenges to be addressed.

Analysis and results
Development of the Jordan River can be seen as a gateway to peacebuilding and economic prosperity within Jordan, Palestine and Israel, who all currently share polluted crossborder streams. With ISIS identified by Jordan as a real threat to national security, Jordan's environmental and economic crises can render the country more vulnerable. It is thus of regional interest to cooperate with Jordan in order to increase its resilience, particularly along the border region in the Jordan Valley, where a restored and rehabilitated river is crucial for the future of half a million people.
The Master Plan comprehensively outlines a pathway to reaching an achievable and equitable agreement on the allocation of resources and management of the Jordan River. It presents additional opportunities to not only build trust with Palestinians, but to integrate Israeli leadership in the water sector to help stabilize the situation at a regional scale. This would be at a low political cost to Israel, but with high political gain to both sides. Given the implications of transboundary water and sanitation issues for health, livelihoods and security in the region, the three governments have clear vested interests in working together to reach new arrangements for the Jordan River.
Conclusions and recommendation
EcoPeace aims to get the three governments of Israel, Jordan and the Palestinian Authority to sign off on a Memorandum of Understanding on the Creation of the Jordan Valley Trust Fund. This will give effect to thirteen critical interventions from the 127 interventions identified in the Master Plan that adapt to changing conditions. The projects would be supported by the creation of an international trust fund under the management of the World Bank, and the appointment from each government of a representative to a Jordan Valley Trust Fund Steering Committee.
Supporting participatory water resource management to avoid conflicts over water

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Keywords
Water supply and availability, water security, sustainable water resource management, inclusive and participatory stakeholder dialogues, conflict prevention

Highlights
• Establishment of multi-stakeholder dialogues to strengthen public participation in water management, ensure a fair water distribution and prevent water-related conflicts
• Capacity development trainings for water utilities to improve water supply and minimize water losses
• Water network rehabilitation to improve water availability as well as installation of barrier-free access points to water facilities

Introduction and objectives
Water scarcity, overexploitation of water resources and a large influx of Syrian refugees lead to insufficient water availability in refugee-hosting communities in northern Jordan which fuel conflicts over scant resources. Therefore, the GIZ project establishes participatory and inclusive exchange mechanisms to strengthen the participation of local community members in water resource management as well as rehabilitates the water infrastructure to improve water availability. By ensuring just access to safe drinking water, increasing water-use efficiency and strengthening the participation of local communities in water resource management, the project contributes to achieving SDG 6.

Methodology approach
The project follows a multi-level approach and combines interventions at micro level to enhance participatory development with measures at the meso level to improve the communal water supply and storage infrastructure. Moreover, it discusses ways on how to sustain the participatory approach in the long run. The applied approach of the project seems to be highly effective in improving water availability and enables stakeholders, especially political decision makers, to recognize the benefits of participatory approaches in water resource management.

Analysis and results
The project is improving the water availability in six host communities in the northern part of Jordan by implementing interventions at different levels. At the micro level, exchange platforms are established where local community members (including Syrian refugees) and water providers jointly discuss water-related issues to ensure that local water supply is closely oriented towards the needs of the population groups. To capture best practices and lessons learnt with the multi-stakeholder dialogues, a participatory resource management concept will be anchored at the local level.
At the meso level, the service and administrative capacities of water utilities are strengthened through training measures to improve the water supply to local communities and to minimize water losses.
Finally, the project aims to improve the water availability for almost 40,000 persons (of which 5,000 are Syrian refugees) by rehabilitating water networks, providing 3,000 modern rooftop water tanks and 2,800 water saving devices to vulnerable households. Additionally, barrier-free entrances in 160 households and 36 public institutions are installed to ensure water access for everyone. Through the implemented measures,
the annual water saving in the six host communities reached almost 335,000 m³ which is enough to secure the daily water needs for additional 9,500 persons.

Conclusions and recommendation
The project fosters a constructive dialogue on sustainable water management, thereby improving the exchange between water providers and water users, alleviating water-related conflicts and contributing to an increased water security in the long run. However, there are obstacles regarding the sustainability of the multi-stakeholder platforms after the project period. Thus, (non-monetary) incentives (e.g. collaboration with water projects, e-participation etc.) might help to overcome the challenges. Based on the project’s success, it is recommendable to discuss and promote participatory formats and approaches in development cooperation projects in the water sector.
Towards cooperative transboundary environmental management in SADC: Politics and harmonisation

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Keywords
Cooperative Transboundary Environmental Management, Southern African Development Community, Transboundary Environmental Impact Assessments, Harmonisation, Benefit Sharing, Regional Integration

Highlights
• Institutional and governance frameworks of RBOs in SADC provide a basis for advancing cooperative environmental management
• Water security interests incentivise RBOs to strengthen cooperative management
• Transboundary Environmental Impact Assessments enable transboundary environmental management to move beyond politics and into practice
• Effective transboundary environmental management advances the SDG debate

Introduction and objectives
Water is central to ecosystem-based management. The transboundary nature and biophysical interconnectedness of hydrologic, ecological and environmental processes necessitate increasingly integrated approaches to environmental management. This demands greater cooperation to reduce risks and maximise benefits shared between nations - particularly political economy benefits from progressing the SDG 6 debate - freshwater ecosystems are essential to human health, environmental sustainability and economic prosperity. Traditional resource and environmental management institutions in SADC promote siloed approaches. Thus, the objective is to identify innovative systems for enabling cooperative Transboundary Environmental Management (TEM) in SADC, a region facing security implications of escalating resource use.

Methodology approach
Desktop reviews and semi-structured key-informant interviews, coupled with comparative analysis underpins the research. A comprehensive literature review, inclusive of international best practice in TEM and pertinent policies and institutional mandates provides the data and basis for interviewing regional resource management institutions including River Basin Organisations (RBOs), NGOs and research institutions, Transfrontier Conservation Areas (TFCAs) and the SADC Natural Resources Directorate. Collated data is analysed using a structured content analysis. Comparative assessment of regional water and environmental management principles facilitates the exploration of harmonised approaches between sectors. This is key to identifying cooperative solutions for effective TEM.

Analysis and results
Several mechanisms for TEM identified in SADC are RBOs and their enabling policies/strategies, TFCAs, policy and law harmonisation efforts, and Transboundary Environmental Impact Assessments (TEIAs). A strengths, weaknesses, opportunities and threats analysis conducted for each identified enabling mechanism highlights a strong entry point for cooperative transboundary environmental management in the form of TEIAs; the political economy realities, and institutional mandates, in the region, constrain the effectiveness of the other identified mechanisms in the short to medium term.
RBO-established institutional and governance frameworks, e.g. the Zambezi Watercourse Commission (ZAMCOM) procedures for notification of planned measures, provide a basis for advancing cooperative management. These require member states to consider the impact of planned developments on other countries, in order to uphold the ZAMCOM-entrenched principle of avoiding significant harm. The policy and law harmonisation processes currently under way in the region, which is largely RBO-driven, demonstrate an appetite for strengthened cooperative management. However, it is evident that principles and instruments between sectors and countries must be better aligned for cooperative management to move beyond political agreements into practice. Doing so is critical to advancing SDG 6 and responding to the security risks of escalating resource use.

**Conclusions and recommendation**
Transboundary environmental management would benefit from the institutionalisation of emerging environmental and water management principles. As relatively advanced institutions, RBOs are well positioned to fulfil this role. TEIA processes provide a strategic entry point to shift TEM beyond the political sphere and into the technical domain. Expanding TEIA principles and guidelines to include considerations of environmental impacts beyond basin and country borders would further advance these aims. Based on research results, it is recommended that SADC develop a set of high-level TEIA principles to frame the development of progressive and standardised TEIA guidelines by RBOs in the region.
Seminar: Ecosystem based water management: From innovation to practice

ABSTRACT VOLUME

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Changing water management practice in Canterbury to address sustainability limits

Presenting: Dr. Bryan Jenkins, Environment Institute of Australia and New Zealand, Australia

Author:

Keywords
integrated water resource management, nested adaptive systems, collaborative governance, sustainability limits, outcomes-based management

Highlights
• Regulating development within environmental limits was ineffective in managing water at sustainability limits of availability and cumulative effects of use.
• A paradigm based on nested-adaptive-systems and collaborative governance led to improvements in water management.
• Strategy shifted from storages on major rivers to integrated management to achieve ten community-defined targets.

Introduction and objectives
Irrigation expansion in Canterbury led to sustainability limits being reached for water availability and cumulative effects of land use intensification. Increasing water availability through storage was proposed. There was strong community opposition to impacts of storage and further intensification. Legislative arrangements give regional councils a regulatory role in environmental assessment of development proposals. Effects-based institutional arrangements proved inadequate to manage resource extraction and cumulative effects of use at sustainability limits. To address these issues, the regional council introduced a non-statutory strategic approach based on nested adaptive systems and collaborative governance. This paper describes this real-world experiment in water resource management.

Methodology approach
The regional council considered water management at four spatial scales: regional level for water availability and land use intensification, catchment level for supply reliability and cumulative effects, tributary level for environmental flow requirements and riparian management, and property level for irrigation and land-use practices. A regional water strategy was developed through a multi-stakeholder steering group under the Canterbury Mayoral Forum and with extensive community engagement. Zone Committees were established to develop Zone Implementation Programmes. Farmer collectives are being established for operational delivery of water management targets. Farmers can develop farm management plans to meet property-level outcomes which are independently audit.

Analysis and results
The shift from applicant-driven development to a community-based strategy led to a shift from a focus on storage on alpine rivers to integrated management for not only increased irrigated area and economic development, but also biodiversity, natural character, kaitiakitanga (Māori stewardship), drinking water, recreation and water use efficiency. The regional strategy investigations demonstrated that a focus on new development would not achieve sustainable development, rather existing users had to improve if there was to be headroom for new users. Water use efficiency improvements were found to be more cost effective than new storage. Also, different forms of storage, such as managed aquifer recharge and off-river storage, were identified that avoided the adverse effects of storage on the mainstems of alpine rivers. There was a need identified for proactive
measures to address such issues as water quality degradation, biodiversity loss, Māori involvement, and ecological restoration.

The development of implementation programmes to achieve community outcomes is leading to improved water management. However, it also identified issues relating to the affordability of proactive measures, equity in allocation, and the need for a public infrastructure agency. Uneven implementation of measures has led to some groups withdrawing from the collaborative process.

**Conclusions and recommendation**

A systems perspective and a change in governance from a regulatory to a collaborative approach has led to improved water management. The change to delivery of multiple community outcomes rather than effects assessment of applicants’ proposals has the potential to achieve sustainable management. Legislative change is needed to reflect an outcomes-based approach rather than an effects-based approach. Legislation also needs to incorporate a proactive role for government rather than just a regulatory role. An investment framework is needed to address funding of proactive measures. Mechanisms for equity in allocation of scarce resources and within contaminant caps is also needed.
Decision structure in Brazilian water management a 2030 agenda perspective

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Keywords
SDG 6, Water Policies, Ecosystem, Stakeholders

Highlights
• Water policies evaluation in Brazil in an integrated perspective
• Challenges and measures proposal for SDG 6 implementation
• Division of power and information systems of water

Introduction and objectives
Although Brazil is considered to have the largest hydrographic system on Earth with 12% of world’s freshwater, the country is facing difficult times in its water management system due to the occurrence of critical events, main water scarcity and inter-agents conflicts. At the same time, despite the ample knowledge of specialists and studies, persist the difficulties of response and the challenges to scale up good practices and lessons learnt from different water uses and also from integrated water and environment management. The present work shows actions launched by Brazilian stakeholders due to develop a strategy to implant and monitor water.

Methodology approach
The study counts on three pillars that groups contents and delineates the methodology based in documental review, exploratory data analysis, and interaction with stakeholders:
1) Analysis of successful and hindrances elements in water management experiences, using survey and a semi-structured questionnaire applied to stakeholders;
2) Recognition of the level of divergence among the pathways to management water systems in a selected group of seminars in Brazil in 2017;
3) Identification of challenges on databases and information systems in water resources.

Analysis and results
The main result of the present research is a structured and critical analysis about the level of power division and social participation on water resources management system. Other result is a review of the challenges on water management databases including possibilities and constraints to collect, organize and share information in supporting decision making process on water management, sanitation and ecosystems. A proposal to improve state measures inside WASH management instruments was also launched to support a conception of a model to implementation and monitoring structure for SDG 6, enhancing political-institutional, financial and technical-operational elements.

Conclusions and recommendation
The main result of the present research is a structured and critical analysis about the level of power division and social participation on water resources management system. Other result is a review of the challenges on water management databases including possibilities and constraints to collect, organize and share information in supporting decision making process on water management, sanitation and ecosystems. A proposal to improve state measures inside WASH management instruments was also launched to support a conception of a model to implementation and monitoring structure for SDG 6, enhancing political-institutional, financial and technical-operational elements.
Development of a curated global compendium of hydro-ecological data

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Keywords
Aquatic ecosystem descriptors, conservation, biogeographic data, water management, wetlands

Highlights
Global freshwater conservation efforts frequently are hampered by coarse, low-quality, patchy, or inconsistent data sources. We will discuss progress and present an updated roadmap towards a comprehensive, high-resolution hydrographic database of global freshwater ecosystem characteristics, represented by a catalogue of biotic and abiotic attributes as well as social data.

Introduction and objectives
The importance of the world’s freshwater systems as providers of biodiversity and other ecosystem services is undisputed. While computational power has increased exponentially and many planning tools are now freely accessible, data availability is still a key issue. To make informed conservation decisions, data on environmental, biotic, social and economic attributes will have to be collected and analysed. Globally, environmental datasets are increasingly collated, but they differ in their spatial or temporal consistencies, accuracy and technical formats. A consortium of researchers, NGOs and intergovernmental organisations are currently working towards a global compendium of standardized stream and catchment attributes, termed HydroATLAS.

Methodology approach
To create a map repository based on abiotic variables we collated over 250 variables in >40 classes using established datasets from either free, publicly available sources or from collaborators who provided their data for this project. Based on the watershed and stream network templates of the HydroSHEDS family of products, data were aggregated and propagated to nested sub-basins at multiple scales, as well as to individual river reaches, both extracted from the underpinning hydrography at 15 arc-second (~500 m) resolution.

Analysis and results
The first version of HydroATLAS has the following attribute themes (with examples):
- Hydrology (discharge, runoff, wetland inundation, groundwater table depth)
- Climate (temperature, precipitation, evapotranspiration, snow, aridity)
- Physiography (elevation, slope, landform)
- Land cover (vegetation classes, ecoregions, forests, wetland classes, habitat types)
- Soils/geology (percent clay, silt, sand, organic carbon, geology classes)
- Human influence (cropland, pasture, irrigation, population, human footprint)

These attributes have been mapped to approximately 1 million sub-basin units worldwide (average size 130 km²) and 8 million river reach units (average length 4 km). Attributes that have an expected influence on downstream catchments have been accumulated along the river network and/or are summarized as upstream averages. Subsequent analyses can thus readily include both local habitat conditions as well as upstream influences.

In collaboration with NGOs, scientists, and intergovernmental bodies such as the Group for Earth Observation, we will discuss next steps (e.g., integration of existing global biodiversity data from IUCN; improving socio-economic indicators) and develop a roadmap for continued database curation. We conclude that for success in uptake and legacy, the next generation of hydroecological data need to be seamless and
globally comprehensive; free and accessible; easy to operate; and dynamic - trading off data quality and updateability.

**Conclusions and recommendation**

Global data can provide baseline information in remote areas where little monitoring is available yet stakeholders need to address urgent issues in a timely manner. Especially in developing countries, both government entities and NGOs will have access to a new data source that is free, reliable and globally comparable. We will present an example from Bhutan where the database has been used for a conservation assessment. Issues of governance and community involvement are an important consideration. Our vision is not to produce a proprietary database, but to create an evolving data repository built for and by the freshwater community.
Drivers for ecosystem-based flood management: Insights from three deltas

Presenting Author: Dr. Martijn van Staveren, Wageningen University and Research, Wageningen University, Netherlands

Keywords: Ecosystem-based flood management, water governance, deltas, eco-DRR

Highlights
• in several world deltas, flood dynamics are being restored for various purposes
• ecosystem-based flood management measures can be stimulated from both top-down policy-making directions, but also from the perspective of social movements
• a better understanding and appreciation of environmental dynamics contributes to more sustainable social-ecological (delta) systems

Introduction and objectives
Well in line with the theme of the World Water Week 2018, this contribution highlights findings from a comparative, multi-annual (2012-17) research project on ecosystem-based flood management measures. These measures consisted of the restoration of (seasonal) flooding, for the benefit of both environment (biodiversity, restored land-water dynamics) and human society (improved regional flood safety by spreading out flood peaks). This contribution argues that ecosystem-based flood management measures can be an outcome of top-down policy-making as well as of bottom-up social movements.

Methodology approach
Comparative case study analysis, based on a number of case studies from different parts of the world (Netherlands, Bangladesh, Vietnam). Grey literature review of policy studies and case study material, complemented by series of data collection at case study level (2013-2016).

Analysis and results
The case studies delivered the following key results:
In the Netherlands controlled flooding is heavily steered from a top-down, central governmental perspective. Near flooding caused the initiation of a Room for the River programme which called for restored flooding to reduce overall flood risks in the wider region, and to facilitate natural dynamics. These interventions caused disputes and surprisingly local farmer communities brought forward innovative plans to continue living on mounds in the areas that were appointed for occasional flooding.
Moving towards Asia, in Bangladesh it were local communities who enforced the restoration of controlled tidal flooding. This was done to address severe water logging on lands in the coastal zone. Tidal flooding would scour silted river beds and deposit sediment on the lands. Facilitating ecosystem dynamics (tidal flooding, twice daily) by means of Tidal River Management, as the practice is called, resembles ancient overflow irrigation techniques and is seen as a learning-by-doing measure.
In the Vietnamese Mekong delta, seasonal flooding has been halted by high embankments. Both government authorities and farmers, each from their own point of interest, have been calling for the restoration of seasonal flooding in some designated areas. The intake of fresh nutrients is coupled with increased flood frequencies.
Conclusions and recommendation

Two main points are brought forward here:

1) ecosystem-based flood management can be stimulated from both a top-down perspective (central policy makers implementing new flood management policies and projects) but also from a bottom-up direction (local communities who suggested to restore seasonal flooding). This insight calls for a mode of interaction, or governance of flooding, in which different stakeholders (governmental actors, policy makers, local communities, NGOs) are involved in ecosystem-based flood management.

2) an appreciation of flood dynamics, beyond its association with catastrophes alone, is helpful to consider the positive aspects of controlled (seasonal) flooding for long-term management of dynamic social-ecological systems.
Enabling smart collaboration for the sustainable use of water

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Co-Authors: Mr. Luis Francisco Thais, Aqulytics, Peru

Keywords
collaborative and participative monitoring, open data, water monitoring

Highlights
We designed a unique cloud-based technology platform that integrates multiple historic water records.
We consolidated 1.5 million geo-referenced data entries with physical, chemical, biological and organoleptic parameters, linked to mining discharges.
We incorporate community monitoring, helping communities upload, store and process their data online, including qualitative water monitoring.

Introduction and objectives
Peru’s water monitoring infrastructure linked to extractive activities is scattered, piecemeal and of limited access to the wider public, resulting in the emergence of social-environmental conflicts. We are piloting an open and online water data management system, using tailored algorithms, and participative monitoring technologies that integrate complementary health data that are providing comprehensive insights as to the quality of water resources in mining regions of Peru. The research will share with participants the mechanisms to process and generate data and the findings generated by

Methodology approach
The research combines quantitative and qualitative methodological approaches. Information has been compiled from primary and secondary sources, with a strong focus on data systematization and codification; while generating interviews with different stakeholders related to environmental monitoring of mining activities in Peru. Our research questions where: 1. how can we propitiate an all-encompassing data monitoring system to capture, systematize and measure the quality of water, building on collaborative processes?; 2. how can we support real-time qualitative water monitoring; 3. how can we scale up the process and promote its use for other productive sectors? The data will support informed policy

Analysis and results
We have systematized 1.5 million geo-referenced data entries on water discharges covering physical, chemical, biological and organoleptic parameters (focused on the mining sector). We have identified over 73,000 parameters that exceed maximum permissible levels for the period 1993-2016. The parameters with the highest recurrence are PH, Lead, Total Suspended Solids, Iron, Zinc, Copper, and Dissolved Oxygen. Furthermore, we have also identified that the 73,000 parameters that exceed limits also impact river body readings. Currently, over 100,000 parameters of river bodies near discharge points exceed national environmental quality standards. Furthermore, we are also in the process of interpreting local level results for 382 different mining companies.
Another important result of our research points out to the importance of enhancing the scope and type of information required to build a comprehensive database on the quality of water, and its impact over social-environmental conflicts. Developing new sources of data, including participative and community water monitoring, as well as qualitative information has helped address the gaps found in official data.
Conclusions and recommendation
Lack of access to data and coherent sources on the quality of water linked to mining discharges, together with the absence of verifiable official data require the use of alternative sources and technologies to support the appropriate monitoring of water discharges. Our results show that technology contributes to filing the data gaps of water monitoring while supporting collaboration for the sustainability of water resources.
Environmental report-cards support ecosystem based water management incorporating indigenous values

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Keywords
indigenous knowledge, river restoration, New Zealand, science communication

Highlights
- Environmental report cards provide clear messages about environmental state across values and spatial scales.
- The Waikato River Report Card extended the concept to include biophysical, cultural and economic aspects based on bicultural values of indigenous Maori and Pakeha New Zealanders.
- It is contributing to restoration of the Waikato River.

Introduction and objectives
Water management to achieve measurable positive outcomes rests on a shared understanding of the current state of key values in relation to community expectations and having tools to measure progress in response to management and communicate findings clearly to a wide range of stakeholders. Environmental report cards can assist here by using the familiar format of a school report card (RC) to produce combined scores for key values derived from monitoring data to indicate whether the values correspond to a healthy state. We describe development and initial uses of a RC for the Waikato, New Zealand’s longest river, based on bicultural values.

Methodology approach
The indigenous Waikato River Maori and NZ government have embraced co-management to secure the river’s longer-term health and wellbeing, including a $220M Clean-up Fund and co-management framework to deliver on a Vision and Strategy. Waikato River Authority commissioned us to develop a novel RC founded on Maori cultural values, and including the economy, along with conventional biophysical data of existing international RCs. Our bi-cultural team built on earlier research and cultural knowledge to identify key themes, develop ‘knowledge network’ diagrams linking monitored indicators to drivers and values and the process for choosing indicators and calculating RC scores.

Analysis and results
The RC set the baseline for measuring restoration and provides a framework for focusing restoration efforts. Key components include:
- a framework that links environmental indicators to the aspirations of the Vision and Strategy via the 8 Taura (Maori for ‘strands of a rope’), namely kai (indigenous foods), water security, ecological integrity, experience, sites of significance, economy, water quality, sites of significance that, if restored, will provide for a healthy and well river and people;
- an A to D system for grading the 8 Taura and 64 indicators they are calculated from using existing council monitoring data and best professional judgement, and
- conceptual linkage models of pressure-state-response relationships that identify potential restoration actions for key indicators (e.g., healthy eel and whitebait populations) and environments (e.g., hill farm streams, mainstem river reaches with hydrodams).

The taura and indicator grades for 5 RC spatial units, and their component mainstem, tributaries and lakes, http://versite.co.nz/~2016/19099/files/assets/basic-html/page-1.html highlight where and what aspects
require focus for restoration. The linkage models synthesise existing knowledge on ecological interactions, multiple stressors and the direct and flow-on effects of potential restoration actions. The RC framework has been used to identify priority restoration actions that can be taken by individuals, organisations and industries.

**Conclusions and recommendation**

We contend that framing RCs around indigenous cultural values, and including economic indicators, overcomes barriers to bicultural understanding and co-management of freshwater. This enhanced public engagement. The RC summarises catchment information in tiers that provide multiple levels of information summary; from high-level messages, picked up by national and regional newspapers and TV and radio news programmes, to more detailed sub-catchment taura and indicator gradings, that have informed restoration priorities and key actions. Identified gaps in quantitative data around important values had to be addressed by professional judgement. This is initiating new monitoring, including by Maori groups, to augment council data.
Floods for food: Water spreading weirs turning the tide

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Keywords
Landscape, Pastoralism, Natural-Resource-Management, Innovation, Food Security

Highlights
• Reversing degradation in dry river valleys through floods for the creation of development nuclei, contrary to current dispersed large-scale interventions
• Holistic and integrated approach within a fragile ecosystem respecting socio-cultural patterns
• Rapid prototyping of interventions together with communities and integration into governmental systems

Introduction and objectives
The current paper discusses the findings and experience of an innovative landscape approach that takes the highland-lowland continuum in Ethiopia into account and works with seasonal river systems, turning destructive floods from the highlands into productive fields for the provision of food, fodder and water. The Ethiopian Lowlands only receive minimal rainfall and are thus poorly suited for rainfed crop production. Pastoralism is the predominant form of livelihood and is severely affected by increasing natural resources degradation, putting traditional livelihood patterns under threat that were previously sustainable. Prevalent interventions often target rangeland management systems or work around groundwater utilisation.

Methodology approach
Since 2013 GIZ prototypes a new approach to the sloping ranges between the highlands and lowlands of Ethiopia. Soil and water harvesting methods based on water-spreading weirs are part of a holistic approach. They reverse the effects of strong runoff of rain water and recurring flash floods in the fertile but degraded dry river valley areas, leaving enough discharge for downstream communities. Appropriate locations and equitable future use concepts of the newly created resources are sought together with all involved stakeholders. Construction and maintenance, as well as utilisation are constantly reviewed and improved in joint learning loops.

Analysis and results
In Ethiopia, terracing is known from highland natural resource management. Using an integrated water-spreading weir approach in degraded dry river valleys allowing to work with floods is new to Ethiopia. This intervention leads to deposition of sediments carried with the flood water, which in turn levels the ground, allows vegetation growth and even farming on an increased acreage, and supports the infiltration of flood water into the soil. It is creating large fertile terraces in the former degraded dry river valleys. This allows the local population to farm three cycles per year (rainfed, dryland and irrigated). Moreover, river bank protection is ensured by providing water to trees that stop erosion and by filling up the eroded river bed to its original level. This water and soil conservation approach combined with intensive training strengthens the resilience of the pastoralist and agro-pastoralist population to the impacts of climate change providing economic opportunities and reducing conflicts. Further downstream, the groundwater levels are recharging rapidly, providing water for other users in the same ecosystem. Testing of the interventions was accompanied by feeding the harvested knowledge into research and technical and vocational training plus providing the necessary skills development within the communities.
Conclusions and recommendation
Current interventions for (agro-)pastoral communities on rangeland management or groundwater based development often do not consider the semi-mobile livelihood of the targeted communities enough. Societal change takes time and thus an initial strengthening of traditional livelihood patterns is paramount to foster a sustainable transition. Anchoring the required skills and knowledge on multiple levels and stakeholders to move from a passive to an active management systems provides the basis for a successful upscaling. Still, further prototyping in other comparable ecosystems is necessary to develop this emerging into a good practice, which can easily be picked up and replicated by other actors.
How much groundwater can we pump and protect environmental services?

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Keywords
environmental flows, groundwater, ecosystem services, water management

Highlights
By applying the groundwater presumptive standard for the first time in a project actively involving scientists, policy makers and practitioners, this project is a compelling case study of integrating ecosystem approaches into water management practice.

Introduction and objectives
Groundwater is a critically important source of water for river, wetland, lake and terrestrial ecosystems, yet most frameworks for assessing environmental flows and environmental services have ignored or not explicitly included the potential impacts of groundwater pumping on environmental flows.

Methodology approach
Recently we proposed a new groundwater presumptive standard as is critical as a placeholder to protect environmental flows in rivers lacking detailed assessments. This presumptive standard has been applied for the first time in British Columbia, Canada by scientists, policy makers and practitioners assessing aquifer stress across over 1000 aquifers in the province. British Columbia recently passed the progressive Water Sustainability Act which regulates groundwater use and protects environmental flow, both for the first time.

Analysis and results
The presumptive standard suggests that 'high levels of ecological protection will be provided if groundwater pumping decreases monthly natural baseflow by less than 10% through time'. The final product is a new interactive online decision support tool for water managers that make decisions under the new Act. The decision support tool is based on new modeling and mapping of groundwater recharge, use and the groundwater contribution to environmental flows. Results indicate that high levels of aquifer stress are common in a number of regions, and that this could potentially be impacting ecosystem services.

Conclusions and recommendation
By applying the groundwater presumptive standard for the first time in a project actively involving scientists, policy makers and practitioners, this project is a compelling case study of integrating ecosystem approaches into water management practice.
Industry in action: Case studies of ecosystem-based water management

Presenting Author: Ms. Cate Lamb, CDP, United Kingdom

Keywords
industry, collective action, private sector, ecosystem-based water management

Highlights
Companies increasingly realise that the health of their business is fundamentally tied to the health of the basin. This research analyzes three years of CDP’s corporate water dataset to provide insights into industry uptake of ecosystems-based water management. Case studies of action will be presented along with recommendations for improvement

Introduction and objectives
Rivers, forests, wetlands and numerous other ecosystems underpin modern economies, with many corporations depending on these systems to deliver their products and services. As such, there is a strong business case for protecting and enhancing these ecosystems. But is the private sector investing in these approaches? If so, are they working collaboratively with others in the basin? This presentation will use CDP’s dataset to provide a state of play of corporate action in ecosystems-based water management. By articulating the business case for action and taking stock of successes to date, we can propose future directions for the private sector.

Methodology approach
To assess industry action on ecosystem management, this research combines quantitative and qualitative analysis of CDP’s corporate dataset for the years 2015, 2016 and 2017. Due to the cross-cutting nature of the issues, both CDP’s water and forests datasets were analyzed. Corporate case studies were developed by analysing the following areas of CDP’s questionnaire: companies facing risks driven by ecosystem vulnerability, and how they respond to these risks; companies factoring the current and future status of ecosystems and habitats into their water risk assessments; and companies that have set goals around watershed remediation, habitat restoration, and/or ecosystem preservation.

Analysis and results
The analysis reveals several positive stories: companies are increasingly building ecosystems into their business models. Over 60% factor the status of ecosystems and habitats into their water risk assessments, up from 49% in 2015.

The business case for action is clear: CDP data shows that companies are financially impacted by disruptions to ecosystem services. Danone reported losing €740,000 in finished goods when polluted river water contaminated their lines in certain facilities in Brazil.

The number of companies setting goals around watershed remediation, habitat restoration, and/or ecosystem preservation has steadily increased year on year, becoming the most common goal reported in 2017. For example, Vina Concha y Toro has committed to the protection and conservation of 100% of its 3,200 hectares of native forest in Chile, and Suntory Beverage & Food has set a target to expand the area of their Natural Water Sanctuaries to 12,000 hectares by 2020.

There are also some excellent examples of collaborative action to protect ecosystems, including from South African brewer Distell Group, who set up a river collaborative in Stellenbosch; and APS, the largest electricity utility in Arizona, which participates in environmental flow workshops for the San Juan river basin in New
Conclusions and recommendation
Although companies increasingly understand and apply the ecosystems approach, barriers to action still exist: for example, when concepts like ‘environmental flows’ have not yet been locally defined. Furthermore, it can be difficult for companies to see the business case for collective action at the ecosystem level. One response to this is to encourage companies to engage their supply chains as a first step towards collaborative action. It is hoped that by promoting and discussing these case studies, policymakers and other corporates will be inspired to accelerate the ecosystems approach to water management.
Moving ecosystems from ‘stakeholder’ to ‘foundation’ of water resource management

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Keywords: ecosystem services, indicators, decision support, governance, IWRM

Highlights
- Freshwater ecosystems are chronically undervalued and poorly understood
- Spatial and power asymmetries exist between points of ecosystem service supply and demand, and among administrative jurisdictions and ecosystem boundaries
- The Freshwater Health Index offers a tool, and an approach, to synthesizing information about ecosystem integrity, services, and water governance

Introduction and objectives
While it is now commonly recognized that freshwater ecology, watershed hydrology and dependent human systems should be understood and managed under a holistic framework, one of the initial stumbling blocks is the breadth of information involved in integrated water resource management. We develop a social-ecological framework and corresponding indicators -- the Freshwater Health Index -- to help the various stakeholders in a given basin understand and link ecosystem health to delivery of services. Eleven indicators are measured and mapped at sub-basin scale, including biophysical measures as well as assessments of the water governance system.

Methodology approach
We applied this system of indicators in two case studies -- the Dongjiang basin in southern China and the Sesan, Srepok, and Sekong (3S) tributary sub-basins in the Lower Mekong. Over a period of approximately 12 months we worked with local and national institutions in both basins to apply the framework and calculate the indicators each on a 0-100 unitless scale, based on a combination of remotely sensed, monitored, and modeled data. Additionally, we convened stakeholder workshops where stakeholders weighted the relative importance of indicators and thereby revealed differing preferences and priorities for the basin.

Analysis and results
The initial applications raised interesting perspectives from the stakeholders, such as their perception of weak governance. It also highlighted key data and knowledge gaps, such as groundwater usage, sediment regulation and mining, and the role of biodiversity in underpinning services. In both basins, Ecosystem Vitality -- the health of underlying ecosystems-- scored lower than Ecosystem Services, suggesting that basins were presently meeting human needs, albeit at the expense of the ecosystems. This is emblematic of the tradeoffs that occur when, for example, the connectivity of streams are reduced in order to provide hydropower, flood protection, and a stable water supply to the Pearl River Delta. However, a single assessment does not illuminate these tradeoffs or help stakeholders understand where improvements could be made in the future. Thus we have begun working with stakeholders to model some of these ecosystem dynamics to help head off conflicts. To start, we assessed a phasing in of over 100 dams in the 3S basin and modeled the effects to our indicators of Freshwater Health. A next step in both basins is to expand scenario
modeling to consider future pressure from land use and climate change, and to evaluate options for ecosystem protection and restoration.

**Conclusions and recommendation**

The Freshwater Health Index framework and its accompanying indicators are oriented toward management and stakeholder engagement, and they make a significant contribution by providing a systematic, evidence-based quantitative tool that supports the integrative social and ecological nature of fresh waters at the basin level. We demonstrated that it is flexible and can be adapted to a range of contexts and user needs, providing a much needed implementation tool for operationalizing IWRM. The Index also highlights the vital, yet much neglected, role of governance in safeguarding the delivery of ecosystem services in an equitable and sustainable manner.
Policies to scale up ecosystem-based water management

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Keywords
natural capital, payment for ecosystem services, collaborative approach, policy, water management

Highlights
A range of tools can be harnessed to promote ecosystem-based water management, in particular to manage diffuse pollution. Their diffusion requires conducive institutional and policy frameworks. The paper draws lessons from practical experience with policies that facilitate scaling up ecosystem-based water management, drawing on in-depth case studies from various contexts.

Introduction and objectives
While control of point-source water pollution is improving globally, water pollution from unregulated diffuse sources of pollution continues to rise in both developed and developing countries. The relative lack of progress with reducing diffuse pollution reflects the complexities of controlling multiple pollutants from multiple sources, their high spatial and temporal variability, associated transaction costs, and limited political acceptability of regulatory measures.

The objective of the paper is to take stock of innovative options based on ecosystems, identify the obstacles that hinder their dissemination at scale, and recommend policies that can facilitate their further diffusion in a variety of contexts.

Methodology approach
The paper analyses the water quality challenges facing developed and developing countries. It presents policy instruments that support ecosystems-based approaches, and details several case studies of such approaches to control diffuse pollution. The case studies investigate:

- The policy and institutional context;
- Rationale for the introduction of the policy instrument;
- Instrument design (how the instrument was selected; how it works, who pays and who benefits; how it combines with other instruments);
- Outcomes;
- Challenges with implementation.

The project benefited from expert discussions at a dedicated workshop and in OECD Working Party on Biodiversity, Water, and Ecosystems.

Analysis and results
Prevailing policies to abate diffuse water pollution have limited impact because they do not reach major polluters, or lack finance or supportive environmental regulations.

The greatest challenge of regulating outputs of diffuse pollution is to allocate a pollution ‘cap’ to individual land owners in a way that is equitable and cost-efficient. A promising ecosystem-based approach identified is the natural capital based approach. This allocates diffuse pollution limits based on the underlying capacity of the soil to filter and retain water and nutrients. Shifting to a natural capital based approach offers a basis for assessing the capability of wider landscapes to provide multiple ecosystem services for a range of desired outcomes beyond just economic growth and water quality. Advances in computer modelling offer an opportunity to design policy instruments directly proportional to the amount of estimated pollution generated or reduced from individual properties in the catchment. Payments for ecosystem services is another option, but must be underpinned by enforced environmental regulations so as to achieve additionality. Stakeholder engagement through inclusive water governance is increasingly recognised as
critical to secure support for reforms, raise awareness about water risks and costs, increase users’ willingness to pay, and to handle conflicts.

Conclusions and recommendation
The paper highlights emerging policy solutions, such as a natural capital based approach to allocating diffuse pollution limits to individual property owners, water quality trading, collaborative governance, and outcome-oriented contributions to policy design. It provides a risk-based framework for intervening and policy principles to guide policymakers and stakeholders through the myriad decisions required to establish new or alter existing water quality management regimes. It identifies key elements to successful reform of policies, which can inspire and promote ecosystem based water management.
System-wide tools for managing water and ecosystems

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Keywords
Ecosystems, fish, hydrology, operations, modeling

Highlights
Responding to declines in aquatic habitat availability and species viability, water managers need tools to consider ecosystem needs. Working in California rivers, SEI developed and deployed a generic simulation platform to evaluate options in terms for habitat supply potential and its capacity to meet other more water supply objectives.

Introduction and objectives
Water managers chiefly consider human development objectives paramount, including urban, industrial, energy and agricultural water demand satisfaction. A crucial element is often missing: ecosystems. Policymakers, recognizing the impacts of water development on aquatic ecosystems, are asking water managers to identify the best water management strategies to maintain species’ habitats in rivers where the watershed is highly intervened through infrastructure development, land use change, and urbanization. New tools are required to respond to this imperative. We present an approach that gives ecosystems a seat at the table, providing water managers the information needed to weigh trade-offs that include ecosystem needs.

Methodology approach
A complete understanding amongst water managers of how operations connect to aquatic ecosystem health is lacking. This gap is particularly important in urban settings where the design and operation of the infrastructure targets human needs. Working in water systems in California, this paper presents a simulation modeling platform that integrates hydro-ecological processes within an water operations model developed by a water district, with which the district evaluated the implications of various management scenarios on both water supply and fish species viability.

Analysis and results
This work focused on building and piloting a new tool that streamlines the inclusion of ecosystem needs in water planning. In the process of identifying the right tool, a team of scientists and practitioners came up with an innovative solution by incorporating different sources of data into a single platform. The model, originally constructed with the WEAP (Water Evaluation and Planning) system to inform water allocation and planning, was adapted to generate a complete aquatic habitat assessment at ecologically relevant points and creek reaches. This habitat analysis models daily hydraulic, substrate, and temperature conditions, weights habitat conditions against life-stage suitability curves and thresholds, and composites the suitability of each criteria to answer questions like: how many acres of suitable habitat are available for spawning salmonids at any given moment? How frequently can juveniles successfully out migrate? How many cohorts of embryos will survive to hatching? What is the most upstream passage extent of migrating salmon? The model was linked to visualization tools that show that changes in reservoir releases can affect fish habitat for each lifestage. These visualizations were designed to help water managers and stakeholders evaluate potential modifications to existing reservoir operating rules.
Conclusions and recommendation
The existence of habitat analysis within a water management model has the potential to simulate complex operations and competing allocations so water managers can explore the tradeoffs between water supply goals like municipal demand coverage or groundwater recharge and ecological goals like adequate habitat for anadromous fish. Working with local partners to identify the key ecosystem challenges, gather data, and generate estimates of available habitat is crucial to identify options to safeguard ecosystems. The presentation will focus on presenting the tool integration and recommendations for its applicability in a wide variety of settings.
Upscaling agricultural water management indigenous knowledge practices through agro-ecological zones

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Keywords

Highlights
A study has documented various agricultural water management Indigenous Knowledge Practices (IKP) across the African continent and beyond. It demonstrates that IKP can be upscaled to areas of similar agro ecological characteristics. This can enhance resilience and food security while preserving the natural resource base that sustains rural communities.

Introduction and objectives
Rural African communities sustain their livelihoods mostly through agriculture. Consequently, they are largely dependent on natural resources, particularly water and land. Their interaction with the environment has evolved, over centuries and through generations, into indigenous knowledge practices (IKP). The objectives of this seminar are:

- To highlight the role of IKPs in the sustainable management of land, water and other natural resources
- To demonstrate the opportunity for upscaling IKPs to agroecological zones of similar characteristics
- To contribute to food security, resilience and the preservation of the natural resources
- To share cases from Africa and elsewhere, as collected through a consultative e-forum.

Methodology approach
The following methodology has been used:

- Field visits to selected countries to identify relevant IKPs
- Literature review of similar IKP across the African continent
- Analysis of the information received using GIS and spatial data on agro-ecological zones to establish linkages and identify options for upscaling
- Consultative-e forum facilitated with four Technical Networks of the FAO, the Global Framework for Water Scarcity in Agriculture (WASAG) and other targeted stakeholders
- Analysis of additional case studies from across the world, with special contributions
- Validation of the findings through a webinar with the participants in the forum.
- Preparation of a compendium to be launched during the Stockholm WWW

Analysis and results
The results based on the analysis of the data collected prior to the e-consultation demonstrate that linking IKPs to their agro-ecological zones increases the potential for their upscaling to locations of similar agro-ecological characteristics.

Such linkages were facilitated by the use of Geographic Information Systems (GIS) and spatial data on agro-ecological zones in Africa with the following results:

- A high diversity of IKP for land and water conservation was identified in sub-humid and semi-arid agro-ecologies, respectively accounting for 34% and 23.4% of the total number of identified practices.
• Fewer IKP were identified in arid (17%), coastal and wetlands (14.9%), humid (6.4%), and highland (4.3%) zones.

Additional results are expected from the e-forum consultation that will take place in February and March 2018 and the case studies that will be solicited from the participants, to expand these findings beyond the African continent.

Expected special contributions to the compendium:
• IKP related to water and soil conservation by the Global Soils Partnership (GSP)
• Innovative financing mechanisms that can facilitated the upscaling of IKPs; this will be provided by the working group on Financing Mechanisms of the WASAG partnership.

Thus, an updated version of this analysis and results will be presented during the session.

Conclusions and recommendation
This seminar will demonstrate and/or recommend that in the context of water scarcity, increasing world population, food security, climate change and the ensuing pressure on natural resources:
• Indigenous Knowledge Practices can significantly contribute to alleviating the pressure on natural resources by providing innovative options for their preservation while exploiting them for food production
• Indigenous Knowledge Practices from one agroecological zone can be used in a zone with similar characteristics, thus upscaling their wider adoption
• Opportunities for financing IKPs exist and should be explored innovatively
• The overall benefits of upscaling IKPs include food security, resilience and sustainable natural resources management.
Seminar: Industry’s role in ecosystem and watershed management

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A public-private partnership implements corporate water stewardship in Colombia

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Keywords
Stewardship, Latin America, collective, industry

Highlights
• Collaboration along the value chain can increase the overall system efficiency and reduce water risks.
• Ecosystem’s restoration is a promising outside the fence action, but measuring direct business benefits and long-term interventions remains a challenge.
• Scaling from Colombia to Peru and Chile; and facilitating a Latin American community of practice.

Introduction and objectives
A Public private partnership accelerates the implementation of corporate water stewardship (CWS) in Latin America. The initiative El agua nos une promoted by the Swiss cooperation in partnership with companies, institutions, industry associations, NGOs and consultancies to:
• Assess and reduce water risks and impacts of production sites and value chains
• Motivate corporate collective actions on watershed management
• Publish practices and technologies in the Water Action Hub (UN Global Compact)

About 30 business cases in Colombia, Peru and Chile developed. 2 cases will be presented in detail to better illustrate articulation among inside the fence, value chain and watershed actions.

Methodology approach
Partner companies advance on their CWS journey by assessing their internal and external water risks and impacts (water footprint) along the value chain. They prioritize and invest in reducing the impacts of their own production process. Each company also engages with a strategic value chain stakeholder, either a supplier or a client, to move from optimizing single processes to a systemic approach. Furthermore, the company identifies a relevant action to work with water basin stakeholders to jointly improve water management and ecosystem’s restoration. Methodologies and good practices are shared through a Latin American community of practice.

Analysis and results
Results 2 business cases:
1. Coffee production - value chain collaboration: The impacts assessment showed the removal of coffee pulp as a hot spot of water withdrawal and water pollution. The traditional small-scale systems didn’t provide water treatment. As a solution, a collective system was built by Colcafe Company and the Andes farmers’ association: to process 1.800 Ton coffee (DPC)/year, from 610 farms. Water consumption was reduced from an average of 30 lt /Kg DPC to 3 lt /kg DPC. A water treatment system was also put in place. This collective action increases farmer’s income and reduce time of payment between harvests and sell; improving life quality.
2. Water basin reforestation: Ingredion an agribusiness, and Celsia an electricity company, are located in an area with high agricultural, industrial and urban water demand. Reforestation of river sides, currently degraded land (mainly pastures), were identified as a measure to reduce the water risks. Ingredion and Celsia joined their efforts to create a 20 hectares ecological corridor along the river Arroyohondo that provides freshwater to the Cali and Yumbo districts, where the companies have
their operating plants. Local communities will grow and plant the native species and will raise awareness on the importance of the ecological corridor.

Conclusions and recommendation

- Ecosystems management and water governance requires strong long term commitments from local public and private actors.
- Direct economic, social and environmental benefits should be assessed to assure commitments. This, water benefits should be evaluated by a broad set of indicators (not only related to water) to capture the overall and avoid potential trade-offs.
- Scaling up requires sharing results, lessons and good practices among peers to showcase gains and risk management of an efficient and responsible water use.
Coal industry's contribution to water-ecosystem through gainful utilisation of mine-water

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Keywords
Asia, Coal Industry, Coal India, Mine Water

Highlights
Coal India Limited, World's largest Coal Producer Company has developed an innovative and sustainable model for utilizing mine discharge water from its Coal Mines for different community needs like Drinking Water, Domestic Use, Irrigation, Ground Water recharge, etc.

Introduction and objectives
Western Coalfields Limited (WCL) a subsidiary of Coal India, operates its mines in Vidarbha region which is considered to be one of the driest regions in India with most reservoirs hitting dead storage levels in summer. WCL has found a sustainable solution to this problem by utilizing its huge volumes of mine discharge water. Objective of this project is to recover this Mine Discharge water from Open Cast and Underground mines and supply it to needy areas. One of our projects Kamptee to Kanhan supplies Mine discharge water from Kamptee Open Cast Mine to drinking water channels of Kanhan

Methodology approach
WCL initiated its ambitious Mine Water Utilisation Project to utilise its 30 crore litre/day mine water. Several projects were initiated for different purposes like:
Supply as Drinking Water to Local Populace
Agriculture Use and Augmentation of Ground Water
Revival of Ponds and Rivers
These projects facilitates overflow of mine discharge water from the sedimentation tank of Mines. High Tension pumps (HTP) are used to drain the water from the mine. The HTPs are located at the deepest locations in the seam/strata. Water from different working locations is pumped using small water pumps to the HTP location.

Analysis and results
• For drinking water, WCL Installs RO(Reverse Osmosis) plants and Pressure Filters to supply water to nearby villages and municipalities. Mine water discharge, which is a natural fall out of mining process of the nearby mine is pumped to villages through pipe lines. The water is then purified at RO (Reverse Osmosis) plant and safe drinking water is provided for free of cost to the villagers.
• For agriculture use and ground water recharge, WCL drills boreholes adjacent to a seasonal nallah(channels) and discharged the mine water into it (after its widening and de-silting). Check dams are constructed at the downstream of this nallah, which has enabled to raise the water level over a stretch of approximately 1 km of the course of nallah. This raised water level has caused charging of the ground water table and accumulation of water in nearby open wells, which remained dry since the past 30 years. As the nallah passes along the agricultural fields, farmers are also using this water for cultivating their land. Various activities involving: cleaning, deepening of nallah, revival of open well, construction of check dam, preparation of sand pits etc. has been taken up by WCL in this project.
Conclusions and recommendation

WCL has pioneered in utilizing Mine discharge water for needs of the community in sustainable manner benefiting more than 1,36,000 population. WCL has succeeded in gainful utilization of our mine water and also took a leadership role in replicating this model across other coal companies which have a total mine water discharge potential of 571.6 Million m³/day. WCL has set an example for other mining companies in India and demonstrated successfully that water discharged from Mines can be gainfully used for community benefit. Slowly, this project is changing the way mining industry is looked upon in India.
Greening the construction chain through cleaner production and organizational learning

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Keywords
Cleaner Production, Construction value chain, Micro small and medium enterprises (MSMEs), Organizational learning, green industries.

Highlights
• New partnerships and learning alliances that allowed reducing negative environmental impacts along the construction value chain.
• Radical changes: New green values, policies and organizational culture that brought the integration and institutionalization of innovative cleaner technologies within firms.
• Women environmental leaders and cleaner firms acting as role models.

Introduction and objectives
Construction is a highly polluting activity. In developing countries, large construction firms greatly rely on small and medium-sized suppliers. A large private construction firm in Colombia, is greening its construction activity by encouraging and supporting its small and medium-sized suppliers in the introduction of Cleaner Production (CP) actions. For transferring CP knowledge to suppliers, the large firm created learning alliances and partnerships with the academia, utility and private companies, and NGOs. With the strategy, suppliers were trained in CP, university students were linked for research, women green leaders emerged, and all firms implemented cleaner technologies and sustained them.

Methodology approach
We aimed to demonstrate how CP external sources can help MSMEs in the institutionalization of new CP knowledge by assuming the transfer of cleaner technologies as an intense organizational learning process. A certificate program led by a local university, was the strategy to start raising the large construction firm and its small-sized suppliers’ capacities for intuiting, interpreting, integrating and institutionalizing new CP knowledge, this means their learning capacities around CP. Models that integrate OL and CP, and ‘learning by doing’ and ‘learning by interacting’ methods were used for knowledge transfer. Interviews and quantitative data were used to evaluate the

Analysis and results
A large construction firm and its suppliers acted as the case study, which provided the empirical data to prove that greening the construction chain is possible through CP transfer processes based on OL principles and learning alliances. Networking with external sources and colleagues, through learning networks, has been found as an important facilitator of learning in CP demonstration projects (Bass, 2007; Dieleman, 2007; Stone, 2006; Van Hoof,

Using photovoltaic energy for lighting common areas, 100% use of rainwater for on-site concrete production, 100% reuse of wastewater from brick cutting process, the replacement of 90% of single-use wood forms by durable metal forms, the elimination of drinking water use for construction activities, 100% reuse of backwashing waters for cleaning roads, 50% reduction in paper use, the emergence of women environmental leaders, and new green policies and values, are some of the outcomes achieved by firms, which have been improved and sustained two years after.
The fact that 88% of SMEs suppliers effectively integrated CP is considered significant, since other authors have reported approximately 70% (Van Hoof, 2014) and 40% as the CP implementation rate in MSMEs in demonstration projects (Dieleman, 2007), or even less in developing countries (ECLAC,

**Conclusions and recommendation**

It was proved that CP external providers can effectively help MSMEs in the integration and institutionalization of new CP knowledge when the transfer of cleaner technologies is assumed as an organizational learning process rather than as a transfer of purely technical information. The learning by doing methodology allowed most of the work was done by the firms themselves rather than by the CP knowledge providers, differing from traditional CP projects in which CP consultants are mainly in charge of visualizing, analyzing and testing CP technologies. Large firms together with SMEs suppliers are capable of effectively help with greening value chains.
Identifying impacts of private sector water abstractions: A Kenyan application

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Keywords: water stewardship, abstraction, river basin simulation, ecological impacts, environmental flows

Highlights
- River basin simulation is an effective way for private abstractors to evaluate their risks and impacts on the watershed
- Current risks, and those under future supply or demand scenarios can be investigated.
- We demonstrate an online simulation portal for private and public water managers to share data and analysis.

Introduction and objectives
Private sector water users would benefit from being able to cost effectively evaluate their water supply risks and impact on the wider watershed. Water resources river basin simulation models can achieve both aims, but typically require a range of public and private data and take years to build and calibrate, making them inappropriate for most private abstractors. This UK funded project, in collaboration with WWF and M&S, aims to prototype an efficient and cost effective way for private and public sector water users in a basin to jointly build water system understanding and evaluate risks and opportunities.

Methodology approach
The proposed approach links a generic open-source simulation model to an abstraction license (water rights) database and a secure online geographic interface with varying levels of data access. The goal is to make it easier to build, share and update data and models between private and public water managers. The simulator is provided estimates of hydrological flows, either from global models, calibrated basin models or gauged data. The data access structure is designed so that a river basin agency can grant individual access to abstractors, to evaluate and save scenarios, without them accessing other private license data.

Analysis and results
A proof of concept application of the tool is applied to an upper subcatchment of Kenya’s Tana River Basin. A hydrological model and abstractor database for the area exist. The basin has overabstraction issues and potentially unauthorised abstractions. Our collaborating partner, the Water Resources Authority (WRA) of Kenya, would like to better make use of their abstraction license database in understanding current abstraction and authorising further future licenses. At present it is not easy to consider the interactions between various uses, their cumulative impacts, impacts on environmental flows and implications of future policy- or asset-based
We are collaborating with WRA to define their needs and requests and design a access mode for external organisations such as private abstractors. The river basin model and the licensing database are linked so that individual abstractors can better understand risks and opportunities. Although water quality and flooding could be relevant, initially water supply assessment is the focus.
Conclusions and recommendation
Providing a means for water users to use modelled and observed data alongside their own permitting data to understand their water supply risks and impacts on other abstractors and ecosystems would be beneficial. The ability to assess the impacts of different future water supply or demand scenarios would be a valuable extension. This proof of concept application aims to assess technical issues, obtain feedback from the water stewardship community and produce a working online prototype for the Tana basin case.
Innovative private sector initiatives in addressing water risks

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Co-Authors: Mr. Will Sarni Water Foundry
Ms. Valeria Orozco, Nestlé Waters

Keywords
Corporate water strategy, Value chain water risks, Innovative partnerships, Watershed scale solutions, Valuing water

Highlights
This presentation provides a demonstration of innovative approaches to corporate water strategy that are aimed at building partnerships, driving growth and supporting sustainable water resource management. An overview of how companies are moving beyond risk mitigation to opportunity creation is provided along with several leading examples that demonstrate this trend.

Introduction and objectives
Water is increasingly being used to drive growth and transform risk into opportunity. In doing so, companies are identifying a ‘license-to-grow’ water strategy that often is focussed on supporting sustainable water resource management. This work set out to explore these initiatives further and understand how an appreciation of the full value of water can be quantified to support commercial investment decision-making.

Methodology approach
This work has been developed through a detailed desktop study and discussions with key stakeholders.

Analysis and results
Water scarcity is driving innovation in the private sector – new technology and the application of different partnership approaches to reduce risk and enhance business growth and sustainability. By appropriately valuing water, previous risks can become a business opportunity. Two case studies are used to demonstrate these findings:

1. A major global resources company is moving past the existing legislative limitations in water markets to address water scarcity by ‘making a market’ through leveraging the power of blockchain technology and catchment partners.
2. A US based beverage company has engaged with their stakeholders within their watersheds to address water conservation and security. The results include increased water conservation and improved social license to operate.

Conclusions and recommendation
Corporations are increasingly engaging in water-related investments beyond the site boundary with a focus on managing risk, seeking growth and in doing so defining their ‘social purpose’. Common ‘input/output’ analysis from a site is now being enhanced by recognizing the importance of negotiation on water, the ability to influence, the ability to find partners and the ability to identify revenue. The examples provided demonstrate a broader appreciation of the quantification of the value of water to mitigate risk and find opportunity. Companies are increasingly making water-related investment (and divestment) decisions driven by an on-site need within the context of off-site.
Leveraging artificial intelligence to accelerate solutions to wicked water problems

Presenting Author: Mr. Josh Henretig, Microsoft, United States

Keywords
technology, ecosystems, agriculture, private sector

Highlights
This session will explore the power of AI to address global and local water challenges. We will offer stories and case studies to show the power of AI already at work and discuss potential future use scenarios.

Introduction and objectives
To achieve SDG6, the private sector will need to engage beyond the fenceline to address water risks and contribute solutions to social and environmental issues. There are few societal areas where AI can be more impactful than in helping address water global and local water challenges. Yet these technologies are not yet widely adopted or utilized to their full potential. This session will showcase how the organizations can gain access to these technologies and leverage them to drive more effective water stewardship policies and outcomes.

Methodology approach
At Microsoft, we believe artificial intelligence is a game changer. The AI for Earth program builds on Microsoft's commitment to use AI technology to amplify human ingenuity, advance sustainability, and address water challenges around the globe. Through ongoing projects and partnerships, Microsoft strives to empower people and organizations to develop and deploy technology enabled solutions to water challenges. With an expanded strategic plan and committing $50 million over the next five years to put artificial intelligence technology in the hands of individuals and organizations around the world who are working to protect our planet.

Analysis and results
Already, we are seeing the transformative potential of AI. Through the access to cloud and AI computing resources, educational opportunities on how to use them, and nurturing of innovative projects, the individuals and organizations involved in the AI for Earth program are demonstrating results that improve management of water resources.

The strategic use of Azure and focused machine learning is providing faster, more effective, and lower cost land cover mapping tools to a small NGO that works to conserve the Chesapeake watershed. By using these tools to analyze, monitor, and manage their precious conservation resources, the NGO benefits from increased productivity, allowing them to pursue actionable solutions previously thought unattainable.

In Australia, high labor and import costs, dry weather and the highest variability in climate of any country in the world make farming increasingly challenging. The Yield, a Tasmanian ag-tech company, has created a solution that uses sensors, analytics and apps to produce real-time weather data, right down to field level, helping growers make smarter decisions that can reduce their use of water and other inputs while also increasing their yield.
Conclusions and recommendation

AI for Earth will be a force multiplier for groups and individuals like these who are creating sustainable solutions. As these projects advance, Microsoft will identify and pursue opportunities to incorporate new AI advances into platform-level services so that others can use them for their own sustainability initiatives.

We face a collective need for urgent action to address global water issues. AI technology offers an opportunity to leverage cutting-edge technology to develop innovative solutions to sustainably manage water resources.
Mining sector collective action on water: Challenges and opportunities outside the fence line

Presenting Author: Mr. Scott Miller, Newmont, United States
Co-Authors: Ms. Briana Gunn, Newmont, United States

Keywords
watershed, management, engagement, stewardship, water

Highlights
Mining companies play an important role in the watersheds where they operate. This presentation will provide case studies on the challenges and opportunities that mining companies face related to collaboration with stakeholders in the watersheds where they operate.

Introduction and objectives
This presentation will highlight several case studies where Newmont Mining Company has been successful in collaborating with external key stakeholders and working outside of our fence line. The first example is the Water for Cajamarca project lead by Newmont’s Yanachocha mine. This included providing increased capacity for the Cajamarca water supply system in Peru through improved infrastructure. The second represents collective action with regulatory authorities when representatives from the mining industry, including Newmont supported to the Governor’s Drought Forum in Nevada providing watershed data and technical expertise. This has continued throughout engagement and representation of the mining industry in the Humboldt River Basin Authority where Newmont has collaborated on challenges within the watershed including water rights and availability.

Methodology approach
Reliable and sustainable water sources are vital to our operations. Milling and ore processing activities require large amounts of water from sources that include direct precipitation, rivers and streams, groundwater and municipal water. Our operations also consume water through evaporative and/or entrainment loss (such as seepage) on heap leach and tailings storage facilities, stormwater and process ponds, and waste rock facilities. We work to minimize the amount of water impacted by mining activities through diversion channels and by separating water based on quality to ensure we discharge water in a manner that complies with all laws, regulations and beneficial water use standards. Rising production, changing regulations, growing populations and a changing climate are among the more significant factors increasing our exposure to broader and more complex water challenges. We also recognize the impact our business activities may have on local communities’ access to water. Our commitment includes understanding the availability and uses of water within the watersheds where we operate and developing management methods that reduce or mitigate our impacts on water quality and quantity.
Analysis and results
Developing and implementing an effective watershed strategy allows mining companies to manage risks and maintain a social license for growth while being stewards of the environment during operation, closure and post-closure. The evaluation of the evolving challenges and opportunities play and import role in developing operating plans to manage water as a shared resource.

Challenges:

• Mines have long lives (often spanning decades) with evolving potential impacts within dynamic watersheds lacking appropriate governance.
• Mine operations have historically focused within the fence line on lowering costs and maintaining operational efficiencies for water (e.g. recycle/reuse, dewatering, stormwater management, treatment and discharge). While water efficiency improvements still exist, significant changes in mine water uses require new technology or significant investment.
• Mines operate in remote locations where there may be limited availability/capacity of forums for collaborative management of the watershed.
• Mines, because of formal approvals (e.g. permits, environmental impact assessments) for water use within the fence line, have not historically reacted to challenges in the surrounding watersheds until conflicts development.

Opportunities:

• Large data base of water information that can be used to characterize watersheds, assess impacts, evaluate opportunities and improve governance.
• Ability to leverage water infrastructure design, construction and operational experience to collaborate/support other watershed users and stakeholders in watershed improvement projects.
• Leverage existing economic and social development program related to community water supply and sanitation
• Public partnerships on large water infrastructure projects (e.g. desalination plants, regional dams and sanitation projects).

Conclusions and recommendation
Mining companies are well positioned to collaborate with other water users and stakeholders to identify and mitigate the potential water risks within a watershed.

Newmont has developed a Global Water Strategy to focus on water as a valued asset. This strategy has allowed Newmont to have success in some areas of water management including: collaboration, collective action, research and innovation, management and efficiency. Although there have been significant accomplishments there is still a need to mitigate long-term risks and to progress to the next level of maturity of water stewardship. We need to develop a robust understanding of the watersheds surrounding our operations including the changing conditions and current and future risks and opportunities. The ultimate goal is to delineate actions and partnerships that will secure access to water in a socially, economically and environmentally responsive way.
Public and private roles beyond 'fencelines': Interrogating the boundary critically

Presenting Author: Dr. Therese Rudebeck, University of Oxford, United Kingdom

Keywords
Corporation, water, governance, role, boundary

Highlights
• Critically engages with where the private responsibility ends, and where public responsibility (should) pick up beyond fencelines;
• Finds that the boundary between the public and the private responsibility is fluid rather than fixed;
• In order not to discourage corporate involvement, a more open conversation about boundaries is necessary.

Introduction and objectives
Whilst it is widely accepted that companies have a critical role to play in addressing water issues – within and beyond their fencelines – their specific role and responsibility is still debated. More specifically, one of the greatest points of tension revolving around corporate water stewardship is where the private responsibility ends, and where public responsibility (should) pick up. The aim of this paper is therefore to interrogate this ‘boundary’ critically. The paper makes a valuable contribution to this session, as it illustrates the opportunities and limitations to companies driving innovation and finding solutions to water issues.

Methodology approach
This paper puts forth the idea that the boundary between public and private roles and responsibilities is fluid rather than fixed. The paper suggests that the role prescribed to the corporation is context dependent, and that under certain conditions, the corporation is able to move into what is commonly perceived to be ‘the public domain’. Looking beyond the capacity of the corporation itself, this paper is guided by the question: ‘What factors determine the boundary between public and private roles?’ This study draws on qualitative interviews, as well as case studies from the agricultural and mining industries.

Analysis and results
The research develops a framework where the nature of the boundary is examined from three different perspectives: a moral perspective (where the boundary is determined by subjective values), a circumstantial perspective (where the boundary is determined by the capacity of the public sector to address these issues without corporate involvement), and a sectoral perspective (where the boundary is determined by the corporate sector to which a company belongs). Examining the boundary from these different perspectives will produce different answers to where the boundary is, or ought to be. Whilst the literature on corporate involvement – academic as well as grey – has made great progress in terms of outlining the private and public roles in water management and governance, no study has yet engaged directly with the boundary where the responsibilities of these two actors meet.
Conclusions and recommendation

This paper concludes that the boundary between the private and the public sector is flexible. However, seeing that the last 40 years has seen a complete reversal in the market value composition in terms of tangible and intangible assets, and that the value of intangibles at least in part is determined by public perception, many corporations are worried about overstepping the appropriate mark. A more open conversation about boundaries is therefore critical. Failure to adequately address this may lead some corporations to avoid engagement altogether, which could be detrimental for the health of the world's water resources.
Sinopec: Grey-green infrastructure to serve industry and nature

Presenting Author: Mr. Arnaud Penverne, Veolia, China

Keywords
Industry, permit, China, wetland, oil

Highlights
Beijing Yansan Petrochemical Company (BYPC) processes 10 million tons of crude oil into 494 grades of products. To meet the stringent discharge standards, new wastewater treatment units were constructed, including an ultimate polishing wetland where 1600 m³/h are treated through 9 Ha of land.

Introduction and objectives
BYPC is a fully-owned subsidiary of Sinopec Group, China #1 petro-chemical group. This site is located 50 km south-west from Beijing center. It produces 800,000 tons of ethylene annually, and 120 kinds and 494 grades of petrochemical products, including synthetic resin, rubber, phenol, acetone, etc. As a high profile heavy industry, BYPC is held to a high standard and must comply with some of most stringent environmental discharge standards in the world (e.g. 30 ppm of COD) and reducing its overall water and energy footprint, to preserve its license to operate.

Methodology approach
In 2007, BYPC outsourced the operations of its wastewater treatment facilities to Beijing Yansan Veolia (BYV) as a 50-50 joint-venture company between BYPC and Veolia. The partnership was extended in 2016 to include the management of the cooling, demineralized, chilled and industrial water facilities. BYV manages the full water cycle, with the design, operations and maintenance of the industrial and domestic wastewater treatment facilities, the bromine extraction facility, cooling towers, demineralized water facilities, and the rehabilitated wetland. BYV support its client on its environmental and CSR agenda to the benefit of the environment and the local communities.

Analysis and results
The technologies selected and installed include conventional treatment plus Ultra-filtration/Reverse Osmosis, Dissolved air flotation, Membrane bioreactor, Actiflocarb and TGV filters, plus a Liquid-Liquid extraction for Bromine extraction.
To further guarantee water quality and protection of the local water resource, the existing wetland system is restructured in a succession of 20 terraces, designed for optimum hydraulic functioning, phytoremediation and biodiversity enhancement, by leveraging the diversity and continuity of landscapes, such as water ponds, bank, wet and dry meadow, willow forests, each of which corresponding to particular a habitat. The turbulent flows enhance oxygenation and stirs the microbial fauna to enhance the depurative capacity of the wetland, while laminar flows in a large open area increase hydraulic retention time (HRT) which in turn increases sedimentation and allows a longer contact time with the purification agents (plants and microfauna).
Because Niukouyu park is open to the public, this site also includes a bridge promenade and educational media for local communities to learn about the benefits of wetlands. It attracts 200 people per day, and thousands of professional photographers every year who enjoy the 30 species of birds that re-colonized this biodiversity refuge.
**Conclusions and recommendation**

This project in China is a unique example of combining innovative technology with ecosystem services to create a wetland sourced by industrial petrochemical discharged water. The discharged water meets the tight environmental standards as the Chemical Oxygen Demand remains below 30 ppm, and N-NH4 remains <1.5 ppm (2.5 winter).

This design avoids possible penalties for wastewater discharge non-compliance, which can exceed several million euros. This initiative could be duplicated in other locations, and demonstrates how to integrate grey and green infrastructures.
Trends in water-related innovation to manage water risks

Presenting Author: Mr. Xavier Leflaive, Organisation for Economic Cooperation and Development, France
Co-Authors: Mr. Ben Krieble, Paris School of Economics, New Zealand

Keywords
innovation, risk management, private sector, financing

Highlights
Innovation is central to managing increasing water scarcity and quality risks in the context of degraded ecosystems and increasing demand for water. New empirical analysis shows that water-related technological innovation more than doubled between 1990 and 2013. The analysis provides new findings on global trends and industry- and policy-relevant issues.

Introduction and objectives
Benefiting from water’s myriad productive uses and its role in maintaining ecosystems, while managing water risks, is crucial for economic growth and development. Innovation in water-related technologies can provide a cost-effective means for water users (firms, irrigators, etc.) to manage risks as well as also business opportunities.

This paper analyses global trends in water-related innovation between 1990 and 2013 for over 200 jurisdictions. It identifies the leading countries for water-related innovation and the leading markets where such innovations are diffused, providing valuable insights for policy and financing discussions intended to promote innovation that contributes to water security and sustainable growth.

Methodology approach
Drawing on the most comprehensive data set of its kind, this paper uses patent data from the OECD.Stat database to analyse global trends in water-related innovation between 1990 and 2013 for over 200 jurisdictions. The data cover technologies that can manage risks of water scarcity and pollution, broadly categorised as demand-side, supply-side and pollution abatement technologies. The data outline patterns of invention, including which types of water-related technologies are being patented, where technological invention is occurring and in which markets inventors seek patent protection. It also identifies which countries specialise in water-related innovation.

Analysis and results
New analysis of global trends shows that water-related technological innovation more than doubled between 1990 and 2013. The five largest overall inventors of water-related technologies, by patent count, are the US, Korea, Germany, China, and Japan, with about 70% between them. China and Korea have exhibited substantial growth in their share of world patenting. The top inventor countries are also major potential markets for the technologies, reflecting partly the propensity of inventors to protect their inventions in their country of residence, but also the attractiveness of these markets to foreign inventors.

The countries with the largest share of their own patenting linked to water-related technologies include Kuwait, Saudi Arabia, Chile, Pakistan, and Australia. This suggests that even if countries do not account for a major share of overall water-related technologies, domestic factors, including environmental pressures, can lead to a relative specialisation in water-related technologies.

The most water-stressed countries show a pronounced relative advantage in water technologies, registering about 30% more than would be expected based on their share of overall patents. Overall, the analysis suggests that necessity is only one parent of invention, as a country’s economic size and general propensity to innovate are also likely important factors.
Conclusions and recommendation
The analysis provides valuable insights for policy makers and the private sector working to improve the management of the risks of water scarcity, pollution and impacts on ecosystems. Policy makers can better target policies to support innovation by understanding how their own country ranks and whether it exhibits a relative technological advantage. The private sector can gain insights on where inventive activity is taking place and where it is diffused, highlighting opportunities to better manage risks through innovation. This paper also inspired discussion on approaches to financing water innovation in the context of the OECD-WWC-Netherlands Roundtable on Financing Water.
Water stewardship and business value: Creating abundance from scarcity

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Keywords
water stewardship, industry, business value, watershed, innovation

Highlights
The private and public sectors are reframing water as more than a scarcity and risk issue, through innovation in public policy, technology, financing and business models. Water can ‘fuel’ economic development, business growth, social well-being and ecosystem health.

Introduction and objectives
For the private sector to invest in addressing water risks beyond the fence line we must quantify the value to businesses. We need to expand our view of the value of water and, more importantly, drive improvement in how the private and public sectors are incentivized to incorporate our expanded view of the value of water into their strategic planning. Without action in these areas we fear that we are destined to continue to ‘manage’ water instead of being stewards of our most valuable natural resource, failing to meet the needs of all stakeholders.

Methodology approach
The methodology in developing the case for the business value of water and a roadmap for action consisted of 20 case studies, 6 interviews with industry leaders across a range of sectors, participation in innovation programs and research on brand value. Case studies and interviews included: Nestle Waters NA, Microsoft, Ford, The Coca Cola Company, Intel, Water for People, Oxford University and ABInBev. Research on corporate brand value, socially responsible consumers, investors and rating/ranking frameworks was also performed to quantify business value and, in turn, investment in beyond the fence line actions.

Analysis and results
Companies are just beginning to experiment with strategies of abundance by funding prize competitions, crowdsourcing technology solutions and establishing venture funds. These actions are not held captive by CSR, CR and Sustainability programs – they are more aligned with creating business and societal value. If companies frame water as a critical resource and part of their business strategy (a ‘license to grow’ water strategy) they will invest in outside the fence line initiatives. A 21st-century water strategy is defined by:

- Building and catalyzing ecosystems of stakeholders. Not collective action – tangible joint business planning and execution.
- Quantifying the value of water – business value and economic value (including natural capital).
- Quantify the brand value of a water strategy – what is the intangible value in a water strategy?
- Develop an innovation plan – technology, financing, partnerships (business ecosystems) and business models (also for the public sector).
- Embrace ‘radical transparency’ about water risks and opportunities.
Conclusions and recommendation
The authors believe companies can create value and positive impact beyond our traditional framework of water stewardship. It is about creating value and having an impact beyond the value chain and well outside their fence line. It is solving a ‘wicked problem’ regardless of the footprint of your value chain. It is actively being part of the solution and creating intangible value (brand) by ‘being in the game.’
Seminar: Sustainable infrastructure for inclusive green growth

ABSTRACT VOLUME

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Building inclusive basin resilience: Adopting a ‘livelihoods project portfolio’ approach

Presenting: Ms. Caroline Brown, Pegasys, South Africa
Author: Co-Authors: Dr. Guy Pegram, Pegasys, South Africa

Keywords
resilience, livelihoods, infrastructure, transboundary river basin, southern Africa

Highlights
Adopting a ‘livelihoods project portfolio’ approach to tackling poverty, inclusion and resilience in a river basin is a means of leveraging climate finance and enabling broader, cross-sectoral (hard and green) infrastructure development and inclusive growth.

Introduction and objectives
Transboundary river basins in southern Africa face a range of social, environmental, climatic and political challenges, all of which impact on the resilience of its people, ecosystems and economy. To this end, extensive engagement with river basin organisations, government entities and financiers has indicated a consistent and clear demand for support regarding the development of ‘inclusive water infrastructure’ - that is, climate resilient livelihoods projects that directly address the challenges faced by vulnerable populations within a basin. However, when viewed in isolation, these relatively small-scale interventions are not bankable/attractive investments, and developing and financing them has therefore proved very difficult.

Methodology approach
Individual livelihoods projects are often not viable because they are unable to leverage the linkages between infrastructure (hard and green), ecosystems, water-food-energy nexus value chain opportunities, and other cumulative impacts of infrastructure provision. However, using vulnerability criteria as a means of identifying and developing suites of small-scale projects not only tackles issues of poverty, inclusion and resilience in a river basin, but importantly, acts as an enabler for broader nexus infrastructure development. It results in a bankable portfolio of livelihoods projects that fit within a vulnerability and resilience framework, with increased impact through economies of scale and cross-sectoral reach.

Analysis and results
Using a scientifically robust, stakeholder-validated approach to identify vulnerable areas within a basin informs the conceptualisation/design of livelihoods projects that respond to specific challenges. This approach also provides a consistent basis upon which to justify climate funding applications for suites of these projects (that consider both human development needs and the value of the natural ecosystem). To this end, the UKAID-funded Climate Resilient Infrastructure Development Facility is piloting a water-poverty-vulnerability mapping process in the Cubango-Okavango river basin. The basin has limited water storage, and analysis by the World Bank suggests that this situation is not sustainable as increasing population pressure leads to growing rates of land degradation - ultimately threatening the basin’s internationally important biodiversity status. Research also concludes that the people of the basin are poorer, less healthy and have less education as compared to other groups in their respective countries. To address these social justice issues and drive pro-poor growth, climate resilient water infrastructure will play a key role. This study therefore arose off the back of the Multi-Sector Investment Opportunity Analysis project, with the Permanent Okavango River Basin Water Commission (OKACOM) articulating a need to pilot, mobilise finance for, and scale-up programmes of water infrastructure projects.
Conclusions and recommendation
This approach has been endorsed by several river basin organisations in southern Africa because it has been such a challenge identifying and mobilising funds for small-scale projects. As such, efforts are underway to ultimately expand and apply the approach to the Limpopo and Zambezi basins.
While the methodology remains consistent, its application must be tailored to: i) address specific basin challenges (which largely depend on the natural resource endowments and comparative advantages of the river basin’s member states); and ii) make use of previous studies and available vulnerability, poverty and climate change data per basin/member state.
Can Africa take the lead on sustainable infrastructure?

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Keywords
infrastructure, sustainable, water, sanitation, Africa

Highlights
Explores present efforts on the use and incorporation of green infrastructure across Africa;
Considers the role of MDB's in promoting the development and use of an appropriate mixture of green and grey infrastructure as ‘sustainable infrastructure’;
Outlines a framework to help integrate the approach of sustainable infrastructure into decision-making processes.

Introduction and objectives
Water resources across Africa face multiple risks, including impacts from climate change, increased urbanization, and population growth amongst many others. The promise of sustainable infrastructure as a means of addressing water resource challenges, and SDG6 including Targets 6.1, 6.2, and 6.6, is yet to be fully explored. The objective of the study is to identify African examples of sustainable infrastructure, where a mix of grey/green is utilized, or green infrastructure in action. These are used to develop a framework that can help to ensure that key opportunities for sustainable infrastructural approaches are adequately considered.

Methodology approach
The study seeks to answer two main questions using a mixture of desk research and subsequent analysis/evaluation of case study examples:
1) To what extent can green infrastructure be found in Africa as part of Sustainable Infrastructure, and is this a core or supplementary activity? ‘Core’ refers to using an appropriate mix of green/grey infrastructure explicitly designed to operate in tandem;
2) Are there enough examples of using Sustainable Infrastructure in African contexts, as a combination of grey/green to develop a framework that will enable natural infrastructure to be potentially seen a key asset/opportunity for the water resources sector.

Analysis and results
The study reveals a limited number of examples from Africa, such as built wetlands as part of wastewater networks, however they are not widespread. The capacity and desirability of using green infrastructure has been constrained by different factors, including enabling environments, access to resources, and general acceptance of green infrastructure as a tool. As a major provider of financial resources, this study is timely to explore the role that green infrastructure plays within the AfDB portfolio and therefore could contribute to Sustainable Infrastructure. Overall the review finds that the use of green infrastructure is not regularly promoted or understood, and when it is, then often it is seen as a complementary activity as opposed to being regarded as a core component. Despite this finding, a number of lessons emerge that are critical to understanding how much of a role sustainable infrastructure can play within the AfDB’s future activities, and whether sustainable infrastructure smoothly fits the African context. These are included in the development of a framework to aid understanding amongst policy makers.
Conclusions and recommendation

There is potential for incorporating complementary grey and green infrastructure as sustainable infrastructure across Africa, especially as a tool that can achieve different targets under SDG6 and address the Energy-Food-Water Nexus challenge. However, at first glance, the conditions and enabling environment for applying this appear to be more limited than in other global locations. The study reveals a number of factors that are important for successfully developing sustainable infrastructure - including clear connections between water source and beneficiaries, the presence of active leadership, etc., which should enable more extensive use in the future and take the lead.
Controlling water disasters and building resilience through innovative underground storage

Presenting: Dr. Paul Pavelic, International Water Management Institute, Lao People's Democratic Republic
Co-Authors: Dr. Alok Sikka, International Water Management Institute, India

Keywords
Floods, droughts, groundwater depletion, managed aquifer recharge, Ganges Basin

Highlights
- A new solution has been developed that converts water-related disasters into rural livelihood opportunities that enhances community resilience
- The solution synergizes natural infrastructure (aquifers) with built infrastructure (ponds and canals)
- Piloting has been successful and influenced policy in India with plans for next-level scaling-up

Introduction and objectives
Pragmatic yet effective approaches for controlling the impacts of floods and droughts are greatly needed in many developing countries. Our solution serves to overcome the spatio-temporal mismatch between surface and groundwater supply and demand within river basins through targeted recharge of excess wet-season flows into depleted aquifers. Its application at the river basin scale reduces local/downstream flooding and drought risks by boosting groundwater reserves. This presentation gives an overview of the solution, known as ‘Underground Taming of Floods for Irrigation’ (UTFI), and details the outcomes from its implementation and wider implications for inclusive and sustainable development in the Ganges Basin.

Methodology approach
A mix of research, practical implementation and stakeholder engagement is applied. The evidence-base for UTFI is created through interconnected activities that include site suitability assessments, pilot testing and demonstration, hydro-economic modelling, institutions and policy analysis, community mobilization and capacity building. Thoughtful planning and staging combined with a multi-disciplinary approach serve to ensure that key risks are identified and addressed for smooth transitioning from piloting through to scaling up. Translation of research data to communication tools and other forms of guidance are the basis for engaging with a range of stakeholders, including prospective proponents of UTFI.

Analysis and results
Regional assessments reveal much of the Gangetic Plains is potentially well-suited to UTFI implementation. A pilot trial site was established at the village scale in western Uttar Pradesh in India following a comprehensive site selection process. Three years of testing involving the recharging monsoonal flows diverted from an adjacent irrigation canal via a retrofitted village pond demonstrates that significant quantities of water can be stored underground each year without unduly compromising groundwater quality. Social acceptance of the trial has been encouraging and local governance arrangements are being strengthened.

Integrated hydrologic modelling suggests scaling UTFI across the Ramganga basin would generate significant social and economic benefits by reducing floods, restoring groundwater levels and baseflows, and boosting agricultural production. Scaling-up would also be economically attractive.

Site visits and Open Days organized for government officials, local community and media have helped to better communicate how UTFI functions and its potential applications. This has resulted in strong support from local decision makers. Annual maintenance of the trial site has been integrated with a national flagship program on rural employment and involves strong community participation. UTFI has been formally recognized by the Government of India and included in district irrigation plans that enable next-level scaling-up.
Conclusions and recommendation
Knowledge on the performance, scope and modalities of UTFI has advanced and is continuing to grow. Some inclusion into government policy has emerged within a relatively short space of time. These successes support the view that policy makers and investors across the Ganges can consider UTFI when making investment decisions that relate to the SDGs, water-related disasters, climate change adaptation, watershed management and rural livelihood development. Although current work is firmly grounded in South Asia, the concept emerged in Thailand and there are clear opportunities to apply UTFI to other regions.
Developing a robust water strategy for Monterrey, Mexico

Presenting Author: Dr. Edmundo Molina-Perez, School of Government. Instituto Tecnológico y de Estudios Superiores de Monterrey, Mexico
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Mr. Rodrigo Crespo-Elizondo, Monterrey's Water Fund, Mexico

Keywords
Long-term water planning; complex planning contexts; deep uncertainty; developing countries

Highlights
1. We use advanced computational tools and participatory planning to develop a robust adaptive water master plan for Monterrey, Mexico
2. The resulting master plan considers infrastructure and policy diversification for coping with climate, economic and technological uncertainties

Introduction and objectives
The City of Monterrey in Nuevo Leon is rapidly increasing its demand for potable water due to its growing industrial activity and population. It is widely believed that the expansion of the city’s water infrastructure is a key measure needed to support future water demand. However, environmental concerns of different projects and more importantly climate change and water demand uncertainty have increased the complexity of this decision.

This study describes the results of applying the Robust Decision Making method for developing a water master plan for Monterrey which adapts to unfolding climate and demand conditions.

Methodology approach
This research describes an integrated computational framework that was developed for supporting the State of Nuevo Leon’s water infrastructure decisions. This framework uses three different computational models: a water demand Monte-Carlo simulator, a water supply hydrological model and a dynamic optimization model. This framework is used in a computational experiment that uses a large ensemble of future scenarios exploring a vast space of water demand, water supply scenarios and policies. The resulting database is then analysed using machine learning algorithms to identify the factors that increase or reduce the vulnerability of different policy portfolios.

Analysis and results
Our results show future water demand in the city can be met progressively through a combination of different projects (e.g. efficiency, surface, groundwater and desalination) and policies (i.e. water tariffs). In the short term, small-to-medium scale grey infrastructure that take advantage of different water sources can be used to meet future demand in the face of climate and technological uncertainty. In the medium term, the combination of water efficiency and medium size grey infrastructure projects can help the city meet future demand and save close to 1 billion dollars in infrastructure investments.

Conclusions and recommendation
Our analysis shows that the status quo water plan was highly vulnerable to negative precipitation changes that are well within the span of past experience for the city. While the predominant view before this study was financing a single big alternative, our results showed that this was also a fragile plan since it is critical to diversity risk among the different project options, thus instead of following the traditional planning approach of incremental huge investment, the City of Monterrey should consider developing a diversified and adaptive master plan of project investments.
Disseminating nature based solutions: Gains, evidence of impacts and others

Presenting Author: Ms. Monique Berendsen, Ministry of Infrastructure and Watermanagement, National IHP-HWRP Committee, Netherlands
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Keywords
Nature Based Solutions, evidence-based, enabling environment, case-studies, WWDR

Highlights
• An overview of Nature Based Solution (NBS) case-studies from over the globe which give evidence of the impacts the solutions had.
• Explanations on why a NBS was chosen over grey-solution possibilities.
• Lessons learned of NBS that have been put into practice on the inclusion of governance during the implementation.

Introduction and objectives
The World Water Development Report (WWDR) of 2018 will focus on nature based approaches that are articulated as ‘solutions’ to flag their current, and potential, contribution to solving or overcoming the major contemporary water management problems or challenges. The report highlights the need for evidence of impacts and inclusion of governance of these Nature Base Solution (NBS). This research aims to strengthen the WWDR2018 by collecting NBS from over the globe that are able to show the theory of the report in practice, and by extracting from each study the gains, evidence of impacts and the enabling environment of NBS.

Methodology approach
Guiding principles for nature based solutions as an alternative to or complementary to conventional engineering measures have been developed in the past year (Implementing nature-based flood protection I Principles and implementation guidance. Deltares, GFDRR, the World Bank, Ecoshape and UNDP). The case-study collection will also reflect on the guiding principles and whether the demonstrated cases indeed conformed themselves to these principles.

Analysis and results
The case studies will collectively highlight:
1. what the NBS is and for which problem it has been designed;
2. why the case study is a NBS and why it was chosen above a so-called grey solution;
3. what the hydrological and socio-economic evidence is to demonstrate that the solution was successful; and
4. how it came to be a sustainable solution for the system as a whole and how were policy, governance, financers and other stakeholders involved to enable the implementation of the NBS into this same system.
Conclusions and recommendation
The case-study collection is available on www.naturebasedsolutions4water.com, enabling any user of the WWDR2018 to extract relevant case-studies and the lessons learned to use in governance, education and practice.
Enabling collaborative investment in sustainable infrastructure to restore catchment resilience

Presenting: Prof. Stuart Bunn, Water Future, Australian River Institute, Griffith University, Sustainable Water Future Programme, Australia

Keywords
Ecosystems, Water Quality, Modelling, Agriculture

Highlights
- This project seeks to improve catchment resilience to extreme weather events through improved planning and implementation of green infrastructure in the landscape.
- The aim is to develop spatial planning and visualization tools that can be used to guide on-ground investment to reduce sediment and nutrient loss, and minimize flood risk.

Introduction and objectives
Many catchments in eastern Australia are in poor and declining condition. During intense rainfall events, streams and rivers break their banks causing extensive damage to homes and infrastructure and shifting millions of tonnes of high quality top soil from agricultural areas. Eroded sediment is transported downstream impacting on water treatment plants, decreasing water storage capacity before settling in shipping channels and smothering marine habitats. In our changing climate, this is likely to happen more frequently than before, and there is growing recognition of the need for large-scale and targeted investment in catchment remediation projects as a cost effective long term management approach.

Methodology approach
A spatial planning tool has been developed to explore options for on-ground investment to reduce sediment and nutrient loss, and maximise biodiversity outcomes. An innovative digital interface will enable realistic visual representations to facilitate discussion with investors and the local community. We will use the tools to run scenarios and explore trade-offs and synergies – noting there are multiple and sometimes competing objectives. For each scenario, we will also explore implications in terms of additional public and private benefits (e.g. minimize flood risk). This deliberative process can facilitate broad stakeholder engagement to identify what actions to take and where best to take them, and result in multiple benefits to the community, the economy and the environment.

Analysis and results
As in many parts of Australia, more than half of the channel length of streams in south east Queensland is in poor condition. Clearing of vegetation, modifications to stream channels, frequent burning and overgrazing in headwater catchments has led to a flashier response to rain events, with more water concentrated in the channel network, and increased stream power. To compound this problem, stream banks and gullies have become more vulnerable to erosion – the source of much of the sediment and nutrients that end up in our reservoirs, drinking water treatment plants, ports and coastal waterways. This not only continues to drive up the costs of water management and infrastructure maintenance (e.g. bridges, harbour dredging) but also poses a major threat to coastal ecosystems. We understand the cause of the problem, what actions are effective, and where they will have the greatest benefit.

Downstream beneficiaries are becoming interested in investing in upstream works to tackle the problems at source but on-ground investment to date has been small-scale and often not targeted to maximize outcomes for the least cost. Investors (and environmental regulators) must have confidence that targeted interventions will deliver benefits that not only justify the expenditure but are also socially acceptable and low risk.
Conclusions and recommendation

The challenge is to move beyond the current incremental approach and there is growing acceptance that we need a coordinated, catchment-scale planning approach to optimize investment for multiple benefits. There are also significant institutional barriers to overcome to facilitate implementation at scale. An evidence-based, spatial investment tool can support deliberative engagement and negotiation between the community, government agencies and investors. We believe that building stakeholder confidence through this process is key to mobilizing investment and to overcome remaining institutional barriers to address this problem at the scale required.
Groundwater-based natural infrastructure: An overview and outlook

Presenting Author: Ms. Karen Villholth, International Water Management Institute, South Africa

Keywords
Groundwater-based natural infrastructure, managed aquifer recharge, ecosystem services, integrated water management

Highlights
- Groundwater plays a critical role in sustaining ecosystem services (ESSs), while also itself dependent on ESSs
- Groundwater-based natural infrastructure is an evolving field that offers solutions for enhanced water security and resilience
- The GRIPP network brings partners together to co-develop and outscale solutions

Introduction and objectives
While groundwater supports and underpins many ecosystems and their services, and also itself depends on certain services for its proper and sustainable function, only recently has the term groundwater-based natural infrastructure (GBNI) been coined – in order to emphasize a sweep of solutions that hinges on groundwater and subsurface services and, by manipulating flows, storages and certain biophysical properties, intends to increase water security and resilience through planned and integrated approaches. The presentation gives an introduction and overview to GBNI, various approaches and how these have been applied around the world, the successes, trade-offs and ways forward.

Methodology approach
Through literature and interaction with key players in the field of recognized technologies such as managed aquifer (or artificial) recharge, integrated land management, river bank filtration, and other solutions that hinges on groundwater, a new term groundwater-based natural infrastructure (GBNI) is introduced. It encompasses a multitude of technologies, with various degrees of grey and green infrastructure that uses groundwater or the subsurface to increase water security and resilience. The spectrum from simple and small-scale solutions focusing on enhancing water storage to hi-tech solutions, which also optimises water quality is presented. Critical issues related to socio-economics, governance and institutions are examined.

Analysis and results
The overview highlights that GBNI solutions require integrated and multi-disciplinary knowledge of the biophysical as well as socio-economic and institutional context in order to realize the potential benefits of water security and resilience without compromising ecosystem sustainability. Long timeframes of groundwater response to nature-based infrastructure interventions and the non-visibility of groundwater provide both the challenge as well as the positive prospects of GBNI. When manipulating recharge and flow pathways of water through the water cycle, as a critical aspect of GBNI, the tradeoffs and short- and long-term impacts need to be understood. Some of the positive benefits involve reliable water supply, enhanced performance of groundwater-dependent ecosystems, less evapotranspiration from water storage, possible water quality enhancement, as well as reduced flood and drought risk. Equitability in benefit accrual and financing are aspects requiring further attention, especially in developing countries. GRIPP (Groundwater Solutions Initiative for Policy and Practice) is a global initiative of 30 international partners with a mix of groundwater expertise coming together to highlight the role of groundwater in the 2030 Agenda for Sustainable Development and to co-develop integrated and sustainable solutions that rely on or impact groundwater. GRIPP and collaborating partners are actively pursuing the opportunities that GBNI provide.
Conclusions and recommendation

Knowledge of the scope, options and tradeoffs of GBNI, from a technical and socio-economic perspective, is increasing, but they need further attention in policy development and investment planning when it comes to increasing water security and resilience. Technologies need to be made more widely accessible and tested under various contexts, and impacts for further outscaling better understood. This is critical as groundwater is increasingly relied on for water supply, industry and irrigation. So, assuring these groundwater-based services, while not undermining the groundwater resource, but in fact purposefully enhancing its services and sustainability through well-planned and integrated GBNI approaches is key.
How to assess hydrological performance in water sensitive infill development

Presenting Author: Mr. Xuli Meng, International Water Centre, University of Queensland, Australia
Co-Authors: Prof. Steven Kenway, University of Queensland, Australia
Dr. Ka Leung Lam, University of Queensland, Australia

Keywords
Water metabolism, Hydrological analysis, Open space ratio, Green fence, Water sensitive urban design (WSUD), Integrated Water Management (IWM)

Highlights
This study evaluated how direct urban flows impacted the urban water metabolism indicators of a case study in Brisbane. The novel contributions in this project are to develop the WSUD applications to improve hydrological performance and monitor performance through water metabolism evaluation framework.

Introduction and objectives
This report is searching for better option to mitigate high volumes of stormwater runoff, spatial variation, and decreasing liveability in Norman Creek catchment, Brisbane.

1. To model water performance (water mass balance) in research area with different scenarios;  
2. To assess the hydrological performance in new WSUD options and analyse how they mitigate water-related issues with Integrated Water Management (IWM) perspective;  
3. To generate some recommendations for the future research and development in the study site.

Methodology approach
This study aimed to assess WSUD options for infill development in the Norman Creek catchment through UMEF4Water. Generally, there are six stages in the UMEF4Water for infill development, developed by Renouf, et al. (2016), based on the original concept from Kenway, et al. (2011), involving:

1. Defining the system boundary.  
2. Determining key water-related issues.  
3. Collecting land use data through using spatial analysis tools.  
4. Defining water sensitive infill development scenarios.  
5. Generating a water mass balance.  
6. Assessing water metabolic performance through indicators.

Analysis and results
The linear park from option 8 with maximised implementation has the best perviousness performance, with nearly 6% improvement and those in the other 7 WSUD options improvement less than 3%. Noticeably, option 1 rainwater reuse and option 2 greywater recycling will only effect on a couple of factors in the table without changing imperviousness, runoff (Rs), evapotranspiration (ET) and groundwater infiltration (GI) at all. Moreover, the linear park also has the best hydrological performances on Rs, ET and GI. The estimated figures indicate that compared to base case Business-As-Usual BAU in 2031, stormwater runoff will be as low as 22.3 GL/yr, which is a decrease of over 6%. For evapotranspiration and groundwater infiltration, they will increase 1.3 GL/yr (14%) and 0.2 GL/yr (17%) respectively relative to 2031 BAU. Additionally, all 8 WSUD options are simulated and assessed by one indicator, total stream discharge (Table 5) for hydrological performance analysis. It can be clearly seen that all options will influence streams involving both ‘natural’ flows and ‘anthropogenic’ flows, but only option 2 greywater recycling (maximised implementation) and option 8 linear park (maximised implementation) will reduce streams outflow over 5%.
Conclusions and recommendation

This report demonstrates how a ‘water metabolism’ perspective can be used to generate water efficiency and performance indicators to assist water resource management in the study area due to high demand for water sensitive infill development. In addition, this perspective is considering both ‘anthropogenic’ and ‘natural’ water cycles and the interactions between them within the whole catchment.

Three recommendations are:

1. To add more detailed data in the in-depth evaluation system;
2. To develop the integrated corridor strategy to influence the stormwater runoff and overland flow flooding; and
3. To develop more appropriate indicators from an UMEF4Water perspective.
Implementing a social-ecological landscape approach for wetland management

Presenting: Dr. Alan Dixon, Institute of Science and the Environment, University of Worcester, United Kingdom
Author: Prof. Adrian Wood, Huddersfield University Business School, United Kingdom

Keywords
Wetlands, Landscape approaches, Ecosystem services, Socio-ecological systems

Highlights
Outlines the need for a more integrated socio-ecological landscape approach to wetland management in order to balance ecosystem services with livelihood needs and maintain natural infrastructure;
Discusses field experiences of implementing a ‘functional landscape approach’ within several diverse wetland-using communities;
Identifies areas of good practice in working with local communities

Introduction and objectives
There is growing recognition that the complex challenge of maintaining water ecosystems with human development needs does not lend itself to narrow disciplinary-based management solutions, and in recent years attention has turned to how integrated landscape approaches can potentially offer an alternative and more sustainable way forward. In this seminar we draw attention to the important contribution of wetlands to human development in sub-Saharan Africa, and how these complex socio-ecological systems arguably require the adoption of a landscape management approach if their environment and socio-economic benefits are to be sustained.

Methodology approach
Our research over 20 years on sustainable wetland management in sub-Saharan Africa has driven the development of a ‘Functional Landscape Approach’ (FLA), which focuses on analysing and supporting the socio-ecological functional linkages between wetlands and catchments, and identifying specific interventions (e.g. soil conservation, afforestation, buffer zones) that improve the sustainability of landuse and water supply as well as developing resilience to change. Critically, this process places local users at the forefront of adaptive co-management following an initial intervention, and in this seminar we report on action research-led field experiences of implementing the FLA with a range of local communities.

Analysis and results
An overarching theme emerging from this work has been the importance of recognising the socio-ecological uniqueness of wetland-catchment setting; farmer-led participatory research was successful in identifying what was important to each individual FLA community in terms of access to livelihood assets, local institutional dynamics, ecosystem services and the environmental characteristics of the wetland-catchment system itself. This was critical because it recognised that many local users already possess detailed knowledge and experience of landscape linkages, but also because it informed their selection of specific FLA management interventions. While the success of these management interventions has been difficult to monitor objectively within the time-frame of our research, evidence from the field suggests that people can see benefits (e.g. better water availability) accruing as a result of their actions, and critically the FLA has empowered users to organise their own environmental and socio-economic monitoring. All of this has been underpinned by the FLA’s emphasis on facilitating community-based local institutional arrangements that agree on a set of ‘rules’ of engagement between users and the wetland and catchment. As well as being developed to manage resource use, many communities have used this platform to self-organise and empower their production and marketing activities.
Conclusions and recommendation
Overall, the FLA has been positively received and our field experience suggests an enthusiasm among communities to engage in developing their own catchment-wetland management plans, based on their own shared knowledge and experience, and within their own local institutional arrangements. Nonetheless, in all cases this has required a fairly significant level of external support, particularly during the early stages of participatory planning and awareness raising. Notably, in some cases the decline of external ‘backstopping’ post-project intervention has led to a gradual decline in participation in FLA activities, although this also appears to be dependent upon individual socio-economic circumstances.
Improving the framework conditions to facilitate investments in water

Presenting Author: Dr. Astrid Michels, Deutsche Gesellschaft für Internationale Zusammenarbeit, GIZ, Germany
Co-Authors: Ms. Elaine Cheung, Deutsche Gesellschaft für Internationale Zusammenarbeit, Germany

Keywords
water, energy, sustainable infrastructure, climate change

Highlights
- Introduction of greenhouse gas (GHG) reducing technologies to water and wastewater companies
- Support climate protection efforts in the water sector using a cross-sectoral approach known as the urban nexus (water-energy-food)
- Development of strategies for a climate-resilient, low-emissions water sector taking into account all components of the urban water system.

Introduction and objectives
Water and sanitation infrastructure play a major role in the development and growth of local economies. In many developing and emerging countries, water and wastewater utilities are among the largest energy consumers due to high losses of water and energy inefficiency. This will be further exacerbated, as global water demand for water will increase by 55%, while water availability is estimated to decrease by 40%. Green growth comprises fostering development and economic growth as well as ensuring the continuation of natural assets to provide resources and environmental services on which not only human well-being, but all ecosystems rely.

Methodology approach
The project Water and Wastewater Companies for Climate Mitigation (WaCCliM) aims to improve the policy, regulatory and institutional framework of utilities for the integration of emission reduction measures in the water sector. WaCCliM focuses on the wider dissemination of the urban nexus approach, the support for the implementation of national mitigation strategies and the introduction of appropriate financing strategies. With regards to achieving the SDGs and promoting sustainable infrastructure, an enabling environment that facilitates green investments in the water sector, needs to be created. Such green investments include: 1. Low carbon, climate resilient infrastructure, 2. Sustainable management of natural resources.

Analysis and results
The WaCCliM project builds capacity and strengthens public sector institutions to develop green policies and leverage financial resources for a low carbon climate resilient water. At the local level, WaCCliM supports pilot utilities in developing countries and emerging economies to reduce their CO2-footprint through energy and nutrient recovery, water reuse and water loss reduction. At the national level, WaCCliM works with policy makers in the partner countries to improve the regulatory and policy framework to strengthen public sector institutions and develop policies for financing and implementing climate mitigation measures in the water sector. The establishment of frameworks for financing municipal infrastructure is becoming increasingly important. Water funds as well as the strengthening of development banks and the promotion of private investment in the sector improve sustainable infrastructure. An acceptable legal framework protects both, the ambitions of the state and the interests of the investor. At the international level, WaCCliM develops a knowledge platform on climate smart water solutions and scales-up knowledge on water and climate mitigation which favors sustainable infrastructure, through the Energy Performance and Carbon Emissions Assessment and Monitoring (ECAM) tool. Effective implementation helps advocate for improved financing mechanisms, and political incentives to replicate the successes of pilot.
Conclusions and recommendation
The water sector has many aspects that make a substantial contribution to the preservation of natural resources and green growth realistic. This requires framework conditions for a sustainable, forward-looking water policy. Best practices on the development of scalable projects that measurably reduce GHGs are disseminated and replication and up-scaling of GHG-reduction approaches on national, regional and international levels promoted.
Increasing infrastructure resilience in New Orleans to enhance environmental protection

Presenting Author: Mr. Laurent Auguste, Veolia, France

Keywords resilience, hurricane, scenarios, vulnerability, climate

Highlights
In 2005, Hurricane Katrina caused flooding in 80% of New Orleans, causing raw sewage spills leading to significant ecological damage. To be proactive, the city did a risk analysis of the most critical assets. The vulnerability of the water infrastructure was evaluated using current and future climate risk scenarios.

Introduction and objectives
New Orleans has made it a priority to better understand its exposure to a broader set of future risks, transform its systems and become more resilient. Resilience requires global risk management to optimize prevention costs and reduce post-event environmental, economic, and social losses, and the length of the recovery period. The ultimate solution for this region will be a combination of improved grey infrastructure and leveraged green infrastructure.

The local utility provides critical drainage, wastewater and freshwater services to the city. Failure of these trigger infrastructures would have significant impacts on the City's public health, living ecosystems and global attractiveness.

Methodology approach
30 environmental infrastructure and insurance experts, coordinated with city stakeholders to examine 200 drinking water, sanitation and rainwater evacuation facilities, to determine their degree of vulnerability and to recommend the appropriate action to ensure resilience while reducing environmental impact. The Technical and Risk Assessment delivers a detailed and structured resilience plan, focusing on medium to major risks; improved response and recovery time; and a threat analysis on inhabitant safety, business interruption costs, assets damages and environmental exposure over time. One month of city downtime represents five times the expected annual damage to city assets and biodiversity enhancements.

Analysis and results
Key steps for the project included:
Calculation of baseline exposure of physical assets. Approximately 200 Assets worth $3.4bn (13 WWTP, 132 MGD – 1,600 miles/ 83 Sewage pump stations/ 59 WTP, 146 MGD – 353,000 people/35 Drainage pumping stations, 29 BGD) were
Calculation of year 2050 climate exposure of current assets and ecosystems. More than 150,000 hurricane events were modeled in the Atlantic Ocean and Gulf of Mexico
Tracking and monitoring actions and progress using a tailored Resilience tool. The tool supported local decision-makers by identifying assets' criticality and by modeling a threat analysis to determine priorities and build a long-term adaptation strategy including the level of impact on the environment.
Modeling the impact of selected resilience-oriented improvements on current and future climate scenarios to determine potential cost savings.
Development of a strategic plan to optimize investment funds for risk and cost reduction for taxpayers.
The results of the risk analysis provided the city with a detailed strategic infrastructure and environmental plan with prioritized mitigation measures and the basis for an adapted risk transfer strategy, as well as the necessary tools to monitor the implementation progress and effectiveness of these measures.
Conclusions and recommendation
The results of the risk analysis provided the city with a detailed strategic infrastructure and environmental plan with prioritized mitigation measures and the basis for an adapted risk transfer strategy, as well as tools to monitor the implementation progress and effectiveness of these measures. Since the existing level of protection in New Orleans following Hurricane Katrina was already high, the most impactful course of action is a two-pronged approach focused on reducing downtime of operations (and therefore negative indirect damage to city ecosystems) and hardening individual assets with the highest reduction in annual expected losses.
Investments in innovative, urban sanitation infrastructure: Decision-making in Sweden

Presenting: Ms. Maria Lennartsson, City of Stockholm, Sweden
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Co-Authors: Dr. Elisabeth Kvarnstöm. RISE, Sweden

Keywords
source-separation, wastewater, decision-making, nutrient recovery, energy recovery

Highlights
Highly ambitious sustainability profiles and systems investigations have guided decision-making process in Helsingborg and Stockholm, leading to construction (currently on-going) of a sanitation system with three separate pipes for the blackwater, greywater and ground kitchen waste flowstreams in H+ and a similar approach under investigation in Stockholm Royal Seaport.

Introduction and objectives
Two urban development areas in Sweden with very high sustainability profiles are H+ in Helsingborg and SRS in Stockholm. Systems investigations, including e.g. systems’ analyses, legal studies, cost-benefit analyses have guided decision-making process in respective areas, leading to construction (currently on-going) of a sanitation system with three separate pipes for the blackwater, greywater and ground kitchen waste flowstreams in H+ with concurrent separate treatment of each flowstream, whereas a similar approach is under investigation in SRS. Separate collection and treatment of different flowstream increases the possibility for heat recovery from the greywater, increased biogas production and reuse of nutrients.

Methodology approach
In the seminar we will describe the two urban areas from a (i) sustainable infrastructure perspective focusing on sanitation, (ii) the decision-making processes in each example, exemplified by results obtained throughout the investigation periods, including e.g. cost-benefit analyses, heat recovery, (iii) financing of the investments.

Analysis and results
Both cities have a political decision to test sources separating wastewater systems in their environmentally profiled areas SRS and H+. Policies and goals have been formulated, for SRS, the goals were formulated already in 2010, whereas for H+, an investigation process was allowed to formulate more specific goals that were set in 2013. The investigation results show e.g. higher benefits, such as increased potential to recover energy, nutrients and water, and decreased climate emissions. The technical investigations show that the complexity of the infrastructure is comparable to conventional systems and the additional cost is marginal. The initial preparatory and investigation phases were managed in a similar way, in the case of Helsingborg, by the H+ Project office with human resources from different city administrations, and in Stockholm by the City’s Development Administration. Stockholm has not yet taken a full implementation decision. In Helsingborg the decision was taken in 2013. The success of the H+ project is due to having established common vision through a cross-sectoral collaboration. The involvement of key-stakeholders and the support from top-management as well as a team driven by curiosity and ability to think out-of-the-box has been instrumental in the process.
Conclusions and recommendation

- Separate collection and treatment of blackwater and greywater have higher benefit-to-cost ratio than BAT for conventional treatment (Swedish setting), hence representing urban, green infrastructure.

- Planning and implementation of this urban green infrastructure demand a stronger relationship and cooperation between the city planners and the water utility than necessarily exists today.

- This shift towards urban, green infrastructure will shift costs and benefits between actors (e.g. heat recovery possibilities). This acts as a conserving force of the conventional approach, demanding an eagle view of the implementation with an actor with the mandate to steer the development towards implementation of urban, green infrastructure.
Modeling the green-grey tradeoff in the Niger River Basin

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Keywords
Niger River Basin, Modeling, Hydropower, Inner Niger Delta

Highlights
• A novel modeling framework can better incorporate green infrastructure into traditional river basin models
• Climate change affects grey and green infrastructure negatively
• To ensure optimal benefits from grey infrastructure development, reservoir releases need to support flow demands of the Inner Niger Delta

Introduction and objectives
In a river basin context, water, food, energy, and environment comprise a coupled natural-human system where natural processes and human behaviors, while recognised as interdependent and dynamic, remain poorly understood. The Niger River Basin in West Africa is such an interactive system, where the urgent challenge of infrastructure development to meet growing water, food and energy demands, also requires the maintenance of environmental sustainability. This paper uses a coupled agent-based—hydrological model to understand tradeoffs between increased hydropower and irrigation infrastructure development and impact on green infrastructure.

Methodology approach
We develop a novel two-way coupled Agent based-SWAT model to assess tradeoffs between grey (irrigation infrastructure and hydropower generation) and green infrastructure in the Niger Basin. We define ‘agents’ as geographical regions with similar hydrological characteristics and administrative structures. Individual agents can alter parameters in the crop production and reservoir modules in SWAT, to reflect real world adaptive human decisions. We then test different climate and socioeconomic scenarios.

Analysis and results
We find that construction of new grey infrastructure increases the probability that hydro-ecologic indicators will fail meeting targets in areas of fisheries hotspots. Similarly, the development of new irrigation infrastructure affects green infrastructure outcomes. Changing priority between green and grey infrastructure does not alter outcomes substantially as infrastructure construction is limited in the basin, but if planned infrastructure is built, then ecosystem health will be substantially affected. Climate change, in general, has a negative effect on all three sectors while temperature increase affects in particular irrigated crop production and precipitation decreases affect hydropower generation. Climate stress test results show that dam development has the potential to partly mitigate these negative effects, but ecosystem health would still be adversely impacted.

Conclusions and recommendation
To ensure that green infrastructure can be maintained during rapid economic development with grey infrastructure development requires incorporation of green infrastructure needs during project design and operations. However, it is unlikely that all adverse impacts can be avoided.
Natural and built infrastructure can co-deliver basin development

Presenting Author: Dr. James Dalton, International Union for Conservation of Nature, IUCN, Switzerland

Keywords
Natural infrastructure, trade-offs, climate change, ecosystem valuation, political economy analysis

Highlights
Tracking natural and built infrastructure costs and benefits (economic, ecological, engineering, and social) and their trade-offs under plausible climate change scenarios helps decision-makers better design natural and built infrastructure interventions. A political economy lens helps further target accessible financing channels to promote investment in natural infrastructure for sustainable basin development.

Introduction and objectives
Built infrastructure brings essential services: energy supply, irrigation for food production, water supply and flood protection. However, historically, infrastructure planning has often ignored the environmental, social and cultural consequences of development. Recognising, valuing, and investing in natural infrastructure of river basins enables sustainable green growth. Tracking the multiple quantitative benefits of both natural systems and built infrastructure allows us to optimize mixes of interventions that both maximise and balance the allocation of resources to enable economies to prosper sustainably.

Methodology approach
The WISE-UP to Climate project approach combines multi-criteria and multi-sector assessment of benefits and costs with engagement of basin stakeholders to meet basin needs under various plausible climates. A multi-disciplinary approach bridging the natural and social sciences better reveals the value and role that natural infrastructure can play in sustainable development. Stakeholder engagement is initiated right from project start, helping to guide and validate results and build ownership and cooperation.

Analysis and results
Trade-off analyses in the Volta and Tana River basins demonstrates the value of combining natural and built infrastructure in development plans and of considering different future climates. Natural infrastructure not only provides benefits to people and nature but also to existing built systems. A political economy analysis has unpacked this evidence to identify drivers for change in decision-making and potential ‘entry points’ for integrating investments in natural infrastructure.

In Pwalugu, on the White Volta River, Ghana, the quantification and valuation of the benefits of natural infrastructure highlights local level dependency on the timing and quantity of river flow, essential for sustaining livelihoods. Despite the potential impacts of a proposed dam to these benefits downstream, trade-off analysis indicates that a balanced natural and built solution is possible. In the Tana River basin, Kenya, WISE-UP research has demonstrated that natural infrastructure contributes to the performance of existing built infrastructure in the basin; improving irrigation and hydropower production and supporting water supply to Nairobi. By regulating upstream river flows and reducing soil erosion, through the implementation of sustainable management practices, reservoir yields are enhanced and hydropower and irrigation benefits safeguarded, under both current and future climatic conditions.
Conclusions and recommendation

Natural infrastructure is a vital national asset that supports livelihoods, sustains economic development and helps climate change adaptation. However, in many countries globally, natural infrastructure remains undervalued and poorly recognised at the national level. Tracking the benefits from natural and built infrastructure helps to balance and enhance benefits in the basin. Because such mixed portfolios imply benefit trade-offs, these need to be negotiated through transparent and inclusive decision-making processes involving a range of stakeholders. The WISE-UP approach provides methods, tools and stakeholder engagement which together highlight the social, economic and environmental value of synergistic portfolios of built and natural infrastructure.
Promoting pathways to guide investment in sustainable, resilient water infrastructure

Presenting Author: Ms. Kathleen Dominique, Organisation for Economic Cooperation and Development, France

Keywords ecosystems, infrastructure, financing, sustainability, economics

Highlights
Long-term strategic planning for water infrastructure investments, which considers green infrastructure options, can maximise the benefits of these investments and ensure they can adjust to changing conditions. New financing models for green infrastructure demonstrate how the benefits from these investments can support sustainable financing.

Introduction and objectives
Water infrastructure is typically very long-lived and capital-intensive, so ensuring investments can cope with considerable uncertainty (due to climate change, economic and demographic trends) is especially challenging. This requires long-term strategic planning of investment pathways that systematically consider green infrastructure options, which may be more cost-effective and flexible to adjust to changing conditions than conventional ‘grey’ infrastructure. It also requires carefully considering how pursuing a specific project may foreclose future options or inadvertently increase vulnerability to water risks. Emerging experience with new financing models for green infrastructure can help convert the benefits from these investments into revenue streams for investors.

Methodology approach
This analysis draws on on-going analytical work by the OECD focused on promoting pathways for strategic water infrastructure investment, building on country case studies. Examples of new financing models for green infrastructure also benefits from structured discussions with water experts and the experts from the finance community (development finance institutions, institutional investors, commercial banks, asset managers, venture capital firms) in the context of the OECD-WWC-Netherlands Roundtable on Financing Water.

Analysis and results
While financiers are typically focussed on the availability of a pipeline of ‘bankable’ projects, governments should also situate these pipelines within broader strategic investment pathways that contribute to water security and sustainable growth over the long term. ‘Green’ (or ‘nature-based’) infrastructure, such as catchment protection, can result in substantial avoided costs and a wide range of benefits. Such schemes may have modest funding requirements (despite high benefits), but due to the long lag times for benefits related to changes in land use to materialise, a long-term strategy is needed.

Green infrastructure can be used in combination with built infrastructure and should be considered in early stages of designing water investments. Analytical tools are needed to identify the trade-offs between green and built infrastructure and understand how the benefits of these investments can be converted into the revenue streams to support their financial viability.

Dedicated finance facilities can be used to scale up investment in natural capital projects with ad-hoc structured finance solutions for projects focussed on protecting public goods. Such a dedicated facility allows for patient investments with longer tenors than otherwise available.
Conclusions and recommendation
The analysis provides valuable insights for policy makers, NGOs and financiers (development finance institutions, institutional investors, public funding agencies, commercial banks, etc.) to develop and scale up approaches for financing green infrastructure. The analysis also provides insights for governments on how they can move beyond a short-term focus on project pipelines to long-term strategic planning for pathways of investment for water security and sustainable growth.
Smart web-based IT solution for planning of sustainable subsurface infrastructure

Presenting Author: Dr. Catalin Stefan, Technical University Dresden, Germany

Keywords
smart IT, nature-based infrastructure, managed aquifer recharge, water management

Highlights
• Managed aquifer recharge (MAR) is a viable close-to-nature infrastructure
• The shift from economic and ecological costly infrastructure requires technical innovation and smart IT solutions
• INOWAS DSS is a web-based modeling platform for planning, assessment and optimization of MAR applications

Introduction and objectives
The development of nature-based infrastructure requires the rethinking of existing solutions and development of new, innovative approaches for water resources management. The traditional practices include almost exclusively horizontal, above-ground solutions, often with extremely high financial and ecological costs. The novelty of the concept presented consists in shifting the focus on the highly unexploited vertical dimension of conjunctively using the subsurface for water storage, treatment and transport. Natural subsurface infrastructure, if properly designed, can smoothen the highly irregular spatial and temporal discrepancies in water availability and increase the sustainability of urban and rural development.

Methodology approach
Despite their demonstrated economic and ecological benefits, solutions such as managed aquifer recharge (MAR) are still not widespread, partly due to poor access to information and lack of knowledge. The shift from horizontal to vertical water management requires technical innovation and the development of smart planning tools. The INOWAS Decision Support System (INOWAS DSS) fills these gaps by providing a free, web-based modeling platform for planning, assessment and optimization of MAR applications. The system provides smart modeling tools of various degrees of complexity which makes the platform accessible to multiple groups of stakeholders.

Analysis and results
With few exceptions, all available software and decision support systems for water management are desktop-based, which represents a significant constrain in the development and dissemination of smart IT solutions to a large audience. The INOWAS DSS is developed as an open source web-service where modern design elements are combined with powerful server capabilities to guarantee comfortable modeling experience and reliable simulations. In comparison to desktop-based software, the whole workflow is managed directly in web-browser without the need to install additional plug-ins. The web-based implementation allows multi-user collaboration via internet, bringing a global perspective to water resources management. The potential direct collaboration between researchers and decision-makers simplifies the communication and makes the information quickly available everywhere is needed. A flexible project management allows users to work on private, public or shared tasks while the work progress can be saved at any stage and resumed later. Among the tools included are databases and tools derived from data mining (for example the global inventory of MAR applications), simple tools based on analytical equations, and numerical tools for the calculation of groundwater flow models. The user-friendly scenarios management and analysis allows for a flexible interpretation of results and future predictions.
Conclusions and recommendation
The free, web-based INOWAS DSS platform supports planners and decision makers in different steps of planning and assessment of MAR applications. The web-based implementation offers a whole new range of opportunities for collaboration while the multi-layered toolbox complexity makes the platform easily accessible. With its technical innovation, the INOWAS DSS is expected to actively contribute to the promotion and expansion of MAR applications, therewith supporting the shift to vertical groundwater-based natural infrastructure solutions. The platform can be accessed at https://inowas.hydro.tu-dresden.de.
Tracking sustainable infrastructure with near real-time comprehensive assessments

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Keywords
Ecosystems, Near Real-time Assessment, Sustainable Infrastructure

Highlights
- COMPASS is an innovative combination of scientific knowledge, and information technology that detects, evaluates and reports on water resource challenges around the world in a real-time framework at global and sub-global level.
- COMPASS is a principal contribution of the science community to anticipatory planning at all levels of government.

Introduction and objectives
A new, ‘blended engineering’, combining traditional grey with green approaches could provide a cost-effective path to human water security. COMPASS developed by Water Future, UNESCO-WWAP, CUNY, and other partners, identifies areas where grey infrastructure in combination with natural infrastructure can jointly help to support the maintenance of ecosystem services and benefit the population. Such dynamic real-time assessment toolbox is an unprecedented step from the science and digital information community to assist decision and policy makers at different scales in real time, and helps to maximise the impact of their policies and decisions.

Methodology approach
COMPASS collates spatial maps and real-time data to produce retrospective and near-real-time assessment of the state of the global water resource base (2010-present) at a higher resolution than has been done previously, i.e., at 3' (latitude/longitude; ~6 km). It is casted as a suite of metrics represented as a time series, which can be aggregated into an overall water resource system behaviour metric. It is a combination of human dimensions (including socioeconomic indicators) together with a biogeophysical water resource measures. The level of detail in COMPASS goes well beyond national boundary aggregation, with the integration of state-of-the-art geo-databases.

Analysis and results
COMPASS has already produced results which predicts a heavy reliance on traditional engineering to achieve Human Water Security for the remainder of the century. With economic expansion and population growth, global expenditures on hard infrastructure and operations will triple over the next 50 years. Relative increases are most rapid in the developing world mainly in China, India and the non-OECD states. COMPASS also predicts the role of Green Infrastructure spatially at a much finer scale that can reduce the threat to human water security, and finds how the benefits of Green infrastructures varies from the region with a dense population (low) to remote parts of the Globe (High). Also, COMPASS spatially identify the areas (including upstream protected areas) where combined impact of grey and green infrastructure is higher and suggesting an important role for natural capital in global water security threat containment.
Conclusions and recommendation
While traditional engineering approaches (often referred as grey infrastructure) without question yields immediate benefits in addressing a target water problem, results suggest that typically incur higher fixed costs, often outstrip the technical capacity of many nations to operate and maintain them, and in many cases destroy the environmental systems (green infrastructure, ranging from wilderness to managed or protected watersheds) that serve as the foundation or source for renewable water supplies. A new, ‘blended engineering’, combining traditional grey with green (ecosystem-inspired) approaches represents an important opportunity space within the overall sustainable development agenda.
Water for the city: ‘Greening’ grey infrastructure and engaging stakeholders

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Keywords
Water, urban, holistic, dam, sustainability

Highlights
‘Water for the City’ (WfC) project highlights:
• Greening of grey infrastructure, namely optimisation of existing water supply dams, with multiple environmental and socio-economic benefits
• Stakeholder engagement introducing planning for green-blue infrastructure towards integrated urban water management in a climate change context
• Education for a new water culture.

Introduction and objectives
WfC was designed by Global Water Partnership–Mediterranean through a multistakeholder approach and is implemented in collaboration with the Alexandroupolis Municipality, N.Greece, and the Alexandroupolis Municipal Enterprise of Water Supply and Sanitation, with the financial support of the Coca-Cola Foundation.

WfC has a two-fold aim: increase urban water supply and promote sustainable water use among stakeholders. A technical application, i.e. the installation of freestanding gates on the local water supply dam, increases reservoir capacity by approx. 14 %. At city level, educational, awareness raising and capacity building activities engage, train and inform stakeholders and the local community.

Methodology approach
Responding to increasing water supply needs in the Alexandroupolis metropolitan area, the technical application on Dipotamos dam spillway increases reservoir capacity through a relatively small intervention in terms of size, cost, implementation time and environmental impact, as the potential water rise level has minimum environmental nuisance according to the environmental impact assessment addendum.

Furthermore, increased reservoir capacity enables less use of coastal aquifers, and mitigates salinization risks and energy demand for water abstraction; it allows the water supply network’s expansion to neighbouring areas and contributes to avoiding investment in new costly large-scale infrastructure with multiple environmental impacts.

Analysis and results
Creating a new urban water culture and rationalizing water demand, by introducing green-blue infrastructure, non-conventional water resources and water efficiency options at city level is a key component of the project. WfC engages authorities and stakeholders, educates students and educators, and raises public awareness on the urban water cycle and efficient water use. Capacity building for local authorities and key stakeholder groups, including the private sector and civil society, is achieved through a serious game that promotes integrated urban water management focusing on strategic planning in the context of climate change uncertainties. This role-playing board game serves as a tool to engage participants and introduces them to multiple conflicts in urban water management and future challenges, while improving communication among stakeholder groups with diverse interests. At the same time, innovative and contemporary educational and communication activities reach out to the educational community and citizens to facilitate the creation of a new water culture, respectful of natural resources, aiming at sustainable development and growth. Overall, this multi-stakeholder project with its holistic approach leads to multiple
benefits, it is consistent with the water-energy-ecosystems nexus approach and the nature-based solutions ‘umbrella concept’ and contributes to long-term sustainability of water resources in coastal Alexandroupolis.

Conclusions and recommendation
Through the application of an innovative technical solution that increases the capacity of the local water supply reservoir with minimum intervention, as well as through the multi-stakeholder partnership approach where local authorities, the civil society and the private sector contribute to the successful implementation of the project, WfC seeks to engage local partners and citizens in the sustainable use of water and aspires to become a successful paradigm to be replicated elsewhere in the world, adapted to the specificities of different areas, geographically and culturally.
Seminar: Is there such thing as innovative financing for ecosystems management?
Seminar: Is there such thing as innovative financing for ecosystems management?

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Adaptive PES: Financing sustainable water management for ecosystem services

Presenting Author: Mr. Peter Vos, Global Green Growth Institute, Republic of Korea

Keywords
Payment for ecosystem services, financial incentives, water conservation, funds

Highlights
In order to embrace a green growth approach where the environment is sustainably managed to achieve multiple objectives, there must be realistic measures to protect ecosystems for meeting human objectives and ensuring long-term sustainability. Payment for Ecosystem Services (PES) is one such innovative financial instrument that achieves multiple objectives.

Introduction and objectives
Ecosystem services are deteriorating at an alarming rate, particularly in developing countries, where competition for land and water is high. They have traditionally been provided free of charge, thus there is little economic incentive to use them sustainably. Payment for Ecosystem Services (PES) is a powerful tool for enhancing economic, environmental, and social returns from investments in integrated ecosystem management, including water conservation, by creating new marketplaces for ecosystem services. This session aims to identify the best approaches to the design, implementation, and monitoring of PES, and its efficacy in achieving ecosystem goals, while ensuring human objectives.

Methodology approach
A green growth approach requires applying market-based solutions for managing ecosystem services. As an organization committed entirely to green growth, GGGI is implementing innovative financial instruments especially in the water sector. One instrument is PES, which is developed using a four-step methodology:

- Setting up program objectives, diagnosing enabling conditions and identifying main hurdles to implementation.
- Conducting in-depth analysis to delineate foundations for PES operation.
- Implementing a PES program, driven by the scope, goals and overall scale. This is a gradual process which provides an opportunity for learning-by-doing.
- Program evaluation, with necessary adjustments that improve efficacy and allow for an adaptive PES program.

Analysis and results
Based on the above approach, GGGI has been involved in the development of financial instruments to support ecosystem services in several countries:

- Costa Rica: FUNBAM 2.0 is a national financing vehicle that mobilises public and private investments for sustainable development. Innovative project pipelines include (1) ‘Forest Plantation Usage Program’, a credit-financing scheme encouraging local agricultural producers to plant trees, thus producing timber, mitigating GHG emissions, and creating job opportunities; (2) ‘Sustainable Timber Management Program’, a marketplace where buyers pay timber producers for the years until the trees are ready to be harvested. Forthcoming programs focus on Blue Carbon and sustainable water management.

- India: GGGI is at the concept stage for the ‘Water Fund for Solar Irrigation Schemes’, a form of PES in countries where unsustainable groundwater abstraction is impacting aquifers and their ecosystems. In India, government subsidies have shielded farmers from the full cost of pumping, leading to groundwater overdraft. By solarizing pumps and allowing farmers to sell surplus solar
power at a feed-in tariff (FiT) to utilities, farmers indirectly conserve water. A Water Fund will top up existing FiTs and close the financial gap between current FiTs and what is needed to incentivize farmers to conserve water.

Conclusions and recommendation
The above cases illustrate the different ways by which PES works and highlights the importance of an adaptive model for PES to be effective. This process of learning-by-doing is necessary to answer some key questions around human behaviour and incentives. For example: i) what are the drivers that shape water use; ii) what incentives, financial and non-financial, promote conservation, and ii) is PES an effective mechanism for long-term sustainable water resource management. By answering these broader questions, decision makers are better informed to design projects and financial instruments, that not only lead to short-term gains, but also achieve long-term objectives.
Economic and financial instruments for insurance ecosystem based approaches

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Keywords
green infrastructure, resilience, sustainable finance, ecosystem services, human well being

Highlights
• presents COMPASS initiative on the opportunities for near real time comprehensive assessment of sustainable infrastructure
• how to design the right economic instruments and target financial resources where these water investments will best pay off.
• Presents preliminary results from the NAIAD project as an example

Introduction and objectives
The important role of natural infrastructure is only coming to the fore now mainly due to exponential changes (population growth and climate change in particular), which are putting pressure on our natural environment. The session will focus on the opportunities for economic instruments and financing of ‘green infrastructure’, (ecosystem-inspired) approaches which either on their own or combined with grey infrastructure (hybrid) could provide a more cost-effective path. Green infrastructure can help reduce our exposure to extreme events due to climate change thanks to damages avoided by giving real examples on the insurance value of ecosystems from the NAIAD project.

Methodology approach
Framed under the COMPASS initiative, the preliminary results from the NAIAD project focus on the role of the insurance value of ecosystems. It provides data on the real application in 9 demos across Europe at three scales (city, medium and large catchments/ aquifers) from an extended cost benefit approach. Here nature based solutions, like aquifer recharge, afforestation, river restoration or soil conservation to name but a few are analysed through their implementation or life cycle costs, foregone value, avoided damages and co-benefits. The financing of natural infrastructure will also be discussed, under the concept of natural assurance schemes.

Analysis and results
Around 90% of natural hazards are water related, and likely to become more frequent and severe due to climate change. The costs of floods in the EU alone have been €4.9 billion a year on average from 2000-2012, predicted to increase fivefold to €23.5 billion by 2050. The European Environment Agency looking at water risks in Europe, also included water scarcity as a problem for many regions with some 45% of European territory expected to be facing water scarcity problems by 2030. In the 2018 Global Risk Report three of the five most likely global risks were environmental—extreme weather, natural disasters, and failure to mitigate climate change extreme weather events, while investments in water management will be critical to achieving the SDGs. Over the next 15 years, an estimated 22 trillion dollars will need to be invested in water infrastructure, which is more than half of the total expected infrastructure investment demand (USD 41 trillion). By including the insurance value of ecosystems through innovative economic valuation techniques and financing, these anticipated needed investments in water infrastructure, can incorporate green
infrastructure and investing is nature as essential to reducing water risks and securing water for human well-being.

**Conclusions and recommendation**

COMPASS is addressing this problem by helping to value natural infrastructure to identify areas of high environmental value where grey infrastructure should be avoided, or identifying areas where grey infrastructure in combination with natural infrastructure can jointly support the maintenance of ecosystem services. The examples from NAIAD in 9 demos across the European Union highlight the insurance value of ecosystems like natural water storage capacity to mitigate risks from natural hazards like floods or droughts. These show real life examples of workable natural assurance schemes that demonstrate viable business cases to invest and value nature for water security.
Establishing a trans-provincial eco-compensation scheme for ecological protection in the Chishui River watershed

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Keywords
Ecological compensation, payment for ecosystem services, transboundary environmental protection, institutional and governance reform

Highlights
• Chishui watershed is a unique region facing growing pressures on ecological systems resulting from rapid urbanization. The eco-compensation scheme is an innovative mechanism for ecological and watershed protection.
• Apart from institutional reforms, a trans-provincial regional office will be established to oversee the management and guide effective investment for environmental protection

Introduction and objectives
The Chishui River is a tributary of the Yangtze River running through the 3 provinces of Yunnan, Guizhou, and Sichuan before flowing into the Yangtze River. It remains as the only naturally running river in the Yangtze River system, with an annual runoff of 9.74 billion m³, and its watershed is classified as a special ecological zone rich in biodiversity. The watershed remains relatively underdeveloped, with per capita GDP at CNY16,040 (USD 2,467) for 2016, about 1/3 of the national average for the same year. The river is the water source for many well-known brands of liquor in China such as Moutai, which depends on the river’s good water quality.

Methodology approach
Key questions:
(i) What are the institutional and regulatory reforms needed to facilitate the establishment and operation of an Eco-Compensation Scheme for Chishui watershed?
(ii) What governance framework is required to ensure that the scheme can function effectively and be managed in the interest of all parties?
(iii) What incentives are required to attract private sector participation in the management and sustainable operation of the fund?
Dialogue and discussion with key stakeholders and government agencies informed the proposed design and structure of the fund, including required institutional and governance reforms, and building on lessons from previous eco-compensation initiatives.

Analysis and results
• Lessons from previous eco-compensation schemes are being reviewed, especially the scheme in Xin’an River Basin in Anhui and Zhejiang Provinces, and other schemes including the Dong River in Jiangxi and Guangdong Provinces, aimed at protecting and improving the water quality in these river systems.
• Although the Xin’an River and Dong River schemes both had clearly defined providers and beneficiaries and clear objectives, they required strong national government involvement and to proceed successfully. This reflects the existence of institutional, legal, and regulatory barriers. In the development phases of these earlier programs, both the downstream provinces—Zhejiang and Guangdong—were opposed to making payments to the upstream provinces without financial
support from the central government, arguing that their tax contributions should be used for investment in watershed management.

- Though the national government has been strongly promoting the development of horizontal eco-compensation programs, much remains to be done to create the right set of incentives and conditions for provinces to take the initiative in addressing trans-provincial watershed management challenges.
- In the Chishui project, innovative measures will include the establishment of a trans-provincial Eco-compensation Fund and regional environment office leading group, comprised of members from each province and central government agencies to manage the operation and structure of the fund.

Conclusions and recommendation

In the past two decades, PRC implemented a range of fiscal instruments for improving environmental quality under the umbrella of eco-compensation schemes, which include not only payments for environmental services, but also taxes, fees, subsidies and other compensation payments. A number of lessons can be drawn from experiences of different schemes implemented in the country, which are informing the establishment of new innovative financing instruments such as the trans-provincial eco-compensation scheme in the Chishui watershed of the upper Yangtze River system. The development of the scheme will provide further insight to the continued evolution of this mechanism in China – in the context of a region that faces unique social economic, and environmental challenges – with high potential for upscaling and application in other regions.
Financial sustainability of watershed conservation schemes: Lesson learned from LAC

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Keywords
enabling environment, governance structures, green infrastructure, blended finance, climate finance

Highlights
The potential of water funds, water stewardship and micro-finance as mechanisms to finance green infrastructure and watershed conservation measure is analysed. Key success factors and guidelines for the design of effective governance structures that ensure long term financial and institutional sustainability of these schemes and make use of the potential

Introduction and objectives
Around the world increasingly frequent extreme events are making the externalities of economic activities visible and creating awareness in the private sector that nature is their real license to operate. Accordingly companies and citizens are more and more showing a willingness to pay for ecosystem protection; companies are more and more aware that only beyond the fence measures can truly protect them in the long term from water stress and ensure business continuity. The great challenges for these investments to happen are low trust and elevated transaction costs; in other words, governance is key.

Methodology approach
Four pioneer experiences of private sector investments in watershed conservation in LAC (Brazil, Peru, Colombia and Ecuador) were documented and analysed to evaluate the potential of water funds and water stewardship as mechanisms to finance green infrastructure and achieve water security. The conceptual framework developed for the analysis of these cases combines key concepts from Transaction Costs Theory, concerning the economic regulation and procurement of public services; with the practical lessons learned in the last decades from the application of Public-Private Partnership models and project finance for the financing and delivery of common and public goods.

Analysis and results
Water fund schemes and their evolution are analysed for Ecuador Ecuador (Quito) and Peru (first water funds and recently launched national public payment scheme for watershed services), and compared with the water stewardship experience of the river basin agency iBiO in Rio Doce in Brazil and the lessons learned by the UNEP program Microfinance for Ecosystem-based-Adaptation to Climate Change (MEbA) in Peru and Colombia. Based on this analysis we have identified key success factors, lessons learned in phasing their implementation and setting effective governance structures that ensure long term financial and institutional sustainability of these schemes. To finalize the challenges ahead are identified and the potential of FinTech and ICT innovations such as blockchain to improve financial sustainability is explored.

This research is part of the development of a Financing Framework for Water Security aims to empower local stakeholders in the choice of adequate governance structures and guides them in the design of an implementation arrangement given particular transaction characteristics and the local institutional context. The findings of these cases in LAC and their applicability to 7 demonstration cases in Europe will be done as part of the European project NAIAD (Nature Insurance value: Assessment and Demonstration).
Conclusions and recommendation
Governments play a crucial role by setting up the regulatory framework and safeguards. Key factors for sustained payments from companies and citizens alike are governance aspects: a) transparency in collection, b) use for intended goals, c) accountability at all levels; as well as technical aspects: d) scientific base to guide investments plans and e) models and tools to quantify and understand the vulnerabilities of different values chains under Climate Change. Financial and institutional sustainability are two sides of the same coin. FinTech and ICT innovations such as blockchain hold a great potential to reduce current transaction costs and create trust.
How to upscale financing for ecosystems management in Africa?

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Keywords
ecosystems, financing, water, sanitation, Africa

Highlights
• Provides an overview of innovative financing for Ecosystems Management in Africa, with specific reference to the Water and Sanitation Sector (WSS);
• Provides lessons learnt from AfDB’s experience in Africa;
• Outlines a framework to better integrate ecosystems management and the WSS, shifting from ‘ad hoc’ to proactive approaches.

Introduction and objectives
The 2030 Development Agenda recognizes the importance of sustainable management of ecosystems as critical to achieving the Sustainable Development Goals, including in the WSS. To undertake this at scale requires new financing strategies and tools to help build, expand and maintain natural infrastructure. But how suitable or applicable are these tools for Africa? And, more importantly, do they have characteristics that allow them to be combined with more traditional sources of financing? The objective of this study is to identify tools or particular characteristics that would support the financing of sustainable infrastructure in a wide range of African contexts.

Methodology approach
The study predominantly uses a desk analysis to identify potential tools, followed by a subsequent diagnostic of their applicability to different financial, social and environmental conditions, to better understand their significance or potential. The study surveys the global landscape of innovative financing tools for the water and ecosystems management, and identifies the tools that were successful or faced specific challenges. Examples including green bonds, green levies, impact investments, venture capital, pooled financing, climate funds, payment for ecosystem services were all evaluated for their potential applicability. Specific case studies from the AfDB’s portfolio are also detailed.

Analysis and results
Whilst there is potential for applying innovative financing methods across Africa, care is required to ensure that tools will actually be useful in the specific contexts across the continent. To do this, the following questions are relevant for the study:
• Has innovative WSS financing been widely applied for ecosystems management?
• What would be the identifiable preconditions for innovative WSS financing to better address ecosystems management?
• How could the WSS benefit from the increased integration of innovative financing for ecosystems management?

The study notes that WSS financing for ecosystems management is not widespread, and its integration tends to be ad hoc rather than proactive. The study assesses the Bank’s experience with ‘Innovative financing Mechanisms’ covering different products and initiatives within and outside the Bank, including carbon financing, guarantee produces, and its experiences with external funding. A number of preconditions were identified as being necessary, including a need to shift the perception of ecosystems management from an
add-on to being a critical assets, and to strengthen the case that natural infrastructure is not just for supplementary activities but may also be a core activity.

**Conclusions and recommendation**

Whilst opportunities for ecosystems management financing are recognized, a number of steps will be necessary, including shifting the perception of ecosystems management in WSS from a supplementary action to being investing in financial and social assets. In this regard, a framework has been prepared, drawing upon the lessons learnt thus far. The AfDB’s experience on using and promoting different ‘Innovative Financing Mechanisms’ within its regional member countries will prove critical to future success of integrating financing of ecosystems management in the WSS on the African continent.
miParamo, environmental financing mechanism to strengthen water funds in Colombia

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Ms. Andrea Yanez, Water Fund Alianza BioCuenca, Colombia

Keywords: Financing, Water Fund, Ecosystem restoration, High Andean ecosystems, Andean Paramo

Highlights: miParamo, a Water Benefit Certificate initiative, is a results-based finance mechanism to promote High Andean Wetland conservation with local families. It aims at strengthening water governance by improving relations among upstream communities and downstream water users. miParamo works as a financial mechanism of Water Fund Alianza BioCuenca.

Introduction and objectives:
The Páramo of Santurban is a Colombian key ecosystem that provide freshwater for two million people, however, anthropic activities and climate change threaten its sustainability. The Alianza BioCuenca, one of the seven Colombian Water Funds, focus on the Paramo of Santurban, to conserve and restore the main freshwater source for the Zulia and Pamplonita river basins.
Objective: Improve conservation of Páramo of Santurban financing conservation and restoration water sources projects based on quantify environmental benefits and improve local livelihoods of upper basin people, by financing-market mechanism based on payment for water benefit related to keep the conservation targets agreement.

Methodology approach:
miParamo identify the lack of economic opportunity for local people located in high mountains, as a driver that increase environmental degradation. The initiative is a results-based technical-finance mechanism that improve local livelihoods of upper basin people in order to show that preserve nature in high Andean forest and the recognition of its value, will increase local income of the families and provide a sustainable way of life.
miParamo uses a market-based approach, focus on a scientific based quantify of water benefit and it’s valuation, related with supply and guaranty of environmental services. The mechanism strengthens the water governance.

Analysis and results:
miParamo design and implementation include three work packages: Technical, Political and Marketing.
By Technical, there are two complementary approaches;
1.- Scientific-based valuation of hydrological environmental services by paramo. There are implemented a twin basins study, complemented by isotopic hydrology and ecosystem services model. The first a result that shows that environmental restoration generate annual increase hydrological regulation about 1500 m³/ha, which implies a lower vulnerability to shortage by loss of base flow in dry season. 2.- There are identified 104 upper basin families, in order to increase natural areas, reduce agricultural impact and improve local livelihoods, that meant a conservation targets agreement; first phase of environmental investment include 70 rural families, located in Mutiscua Municipality.
By political, miParamo is growing-up with coordination and support related with the interest by national government in order to improve payment for environmental services. On May 2017 was published the legal framework to PES in Colombia (law 870 by Environmental Ministry).
BY Marketing, there are communications tools designed, using Transmedia storytelling, in order to generate a scientific-based result to show, in an easy, simple and confident way, in order to offer a path to be involve, to people, water users, companies and government.

Conclusions and recommendation
Water funds are an actual and effective environmental financing mechanism that are increasing and generate key results to improve the sustainability of key freshwater ecosystems; however, financial sustainability is one of key challenges that have to face water funds. miParamo is a results-based finance mechanism that strengthen water fund and open possibilities to reply in other water funds on LAC region. The partners of miParamo are SDC, GIZ, GSI-LAC and Alianza BioCuenca, in the name of Regional Government (Gobernacion of North of Santander) and Regional Environmental
Strengthening enabling conditions for innovative financing for water-related ecosystems

Presenting Author: Ms. Kathleen Dominique, Organisation for Economic Cooperation and Development, France

Keywords ecosystems, infrastructure, financing, sustainability

Highlights
Investments in ecosystems can result in substantial avoided costs and a wide range of benefits. Due to the long-term nature of such investments and the public goods they deliver, innovative approaches to financing are often needed. Examples of innovative financing approaches provide lessons for strengthening the enabling environment.

Introduction and objectives
Investments in ecosystem services generate a range of public and private benefits in terms of valued goods and services as well as reduced water-related risks. Designing innovative financing approaches requires determining how these benefits can be converted into revenue streams, as a basis for cost recovery and to improve the risk-return profile of investments. There is a diverse range of policy instruments that can help to achieve this, including tariffs for water services, pollution taxes, charges to raise revenue for public goods, payments for ecosystems services and value-capture mechanisms.

Methodology approach
This analysis draws on on-going analytical work on innovative approaches to financing water security and sustainable growth in the context of the OECD-WWC-Netherlands Roundtable on Financing Water. It draws lessons learned from examples of innovative financing models that promote investment in ecosystem services and green infrastructure, building on structured discussions with experts from both the water and finance communities (development finance institutions, institutional investors, commercial banks, asset managers, venture capital firms).

Analysis and results
Investments in ecosystems or green infrastructure can result in substantial avoided costs and a wide range of benefits. Such schemes may have modest funding requirements (despite high benefits), but due to the long lag times for benefits related to changes in land use to materialise, a long-term strategy is needed. Further many of these investments deliver valuable public good benefits, which can be difficult to monetise and convert into revenue streams that can attract finance.

Despite these challenges, there are numerous examples of innovative financing models which can effectively combine different sources of finance to support investment in ecosystem services. These require strengthening the enabling environment through policy instruments (tariffs, taxes, PES, value capture) to improve the risk-return profile of investments. Blended finance can play a catalytic role to strategically deploy development finance mobilise additional finance. Dedicated finance facilities can be used to scale up investment in natural capital projects with ad-hoc structured finance solutions for projects focussed on protecting public goods. Such a dedicated facility allows for patient investments with longer tenors than otherwise available.
Conclusions and recommendation
The analysis provides valuable insights for policy makers, NGOs and financiers (development finance institutions, institutional investors, public funding agencies, commercial banks, etc.) to develop and scale up innovative approaches to investments in ecosystems and green infrastructure. It also draws lessons for the design of blended finance vehicles and how challenges can be managed, to ensure development finance can leverage private finance and development outcomes are realised.
Seminar: Investing in freshwater ecosystems and biodiversity: A key development challenge
Seminar: Investing in freshwater ecosystems and biodiversity: A key development challenge

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Balancing built and natural infrastructure investments in Kenya’s Tana basin

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Keywords: ecosystem services, systems modelling, water infrastructure investment planning, climate change, decision making under uncertainty

Highlights
- A water system model of the Tana Basin and multiple performance metrics, including ecosystem services, were co-developed with stakeholders
- A multi-criteria search algorithm used the model to evaluate basin development interventions (assets/policies) and maximise system performance.
- Performance trade-offs implied by different infrastructure investments were interactively visualised for stakeholders to deliberate.

Introduction and objectives
Ecosystem service impacts of built water infrastructure can be significant, yet these rarely receive equal consideration in comparative technical or economic analysis of development options. The WISE-UP to Climate project spent four years developing and demonstrating a new approach to river basin planning in Kenya’s Tana Basin. This uses the best available system-scale impact evaluation to better inform decision makers about the trade-offs inherent to their system’s development. The objective was to show the advantage of a combined built and natural infrastructure design approach to address water-energy-food security, ecosystem service protection, and climate resilience.

Methodology approach
A system model was co-developed with diverse national and basin stakeholders. This involved mapping locations of key ecosystem service provision, and deriving benefit functions evaluating how services are impacted by varying river flow or reservoir storage. Stakeholder interactions took place through bi-annual Action Learning groups and bilateral meetings. Different plausible scenarios of hydrological inflows were generated by downscaling GCM data for the 2050s and passing the resulting precipitation and temperature data through a basin-wide hydrological model. The system model was coupled to a multi-criteria search algorithm to identify efficient and robust interventions based on several performance.

Analysis and results
The output of the search is a set of efficient and robust interventions and their performance over the range of scenarios tested. These outputs are interactively visualised to allow intuitive exploration of the complex relationships between competing interests. Understanding these relationships can help reduce unintended consequences of interventions and develop more balanced ‘performance-based’ development plans. We facilitated multiple interactive sessions during Action Learning meetings to explore user responses to different types of results and visualisations. Users interacted with results in small groups or in an open plenary forum. Stakeholder responses were used to narrow down a range of acceptable system performance trade-offs considering the various stakeholder objectives. The resilience of promising interventions identified by the automated filtering were assessed with further stress testing simulation. Flooding is the driver of most ecosystem services in the lower Tana, and is projected to be increased by climate change. This means more benefits may become available overall, but decisions will need to be made about how best to balance benefits between different interests in the basin. Ecosystem services rival hydropower for monetary value and have distributional effects so the appropriate balance needs to be carefully considered.
Conclusions and recommendation
Taking a performance-based approach to basin intervention design showed how portfolios of combined built and natural infrastructure could better support water-energy-food security, biodiversity conservation, and climate resilience. An Action Learning process was used to align technical analysis with stakeholder needs and to provide regular feedback and iteration on model development and results. The work shows how decisions about balancing the multiple benefits from proposed water resources system interventions under future uncertainty, e.g. from climate change, could be effectively informed by the proposed approach.
Conserving the Lake Tana ecosystem for sustainable peace and livelihoods

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Keywords
Freshwater ecosystem, biodiversity conservation, peace, sustainable livelihoods, siltation

Highlights
Ethiopia’s Lake Tana faces serious threats arising from encroachment, loss of wetlands; heavy deforestation in the upper catchment areas and consequent siltation from feeder rivers; unsustainable investment patterns; and water hyacinth. Climate change added, the Lake would disappear in the very near future with catastrophic species, socioeconomic and political impacts.

Introduction and objectives
In 2007-2010, FESS launched an environmental security assessment study of Lake Tana, Ethiopia to determine threats and implications for socioeconomic, cultural, environmental and political wellbeing of the country and the Nile riparian countries. The study used a multiphase analytical tool that combines data gathering and field interviews. Serious degradation of wetlands around the Lake and its catchment have posed extensive threats, now, made worse by water hyacinth invasion. This paper reviews current situation; establishes a case for conservation of the Lake’s water ecosystem as a critical tool for sustainable peace and development; and proposes holistic and actionable set of recommendations.

Methodology approach
The study involves literature review, analysis of primary and secondary data including household surveys and community focused group discussions guided by the Environmental Security Assessment Framework (ESAF) developed by FESS. ESAF analyzes multiple dimensions of stability and instability (social, economic, political) and links them to losses of environmental resources (water, land, forests) that may arise from overuse, abuse or misuse of them. These changes in resource conditions are treated as a continuum, with instability, heightened tensions, turmoil, and conflict. The ESAF proceeds through eight phases including generating scenarios that project potential environmental security trajectories over the years.

Analysis and results
Lake Tana, Ethiopia’s largest water body, accounts for 50% of the total inland waters in the country, provides livelihoods to close to 5 million people and supports substantive fishing industry and significant hydropower energy. The Lake area and its 37 islands are home to 20 ancient Ethiopian Orthodox Church monasteries - a cultural heritage of national and global significance. Threats to the Lake include: (a) decrease in water levels owing to high population growth and unplanned investment; (b) unsustainable traditional and extensive cultivation practices at the backdrop of growing demand for food; (c) deforestation, soil and water erosion in the upper catchment and consequent siltation from feeder rivers; (d) water quality deterioration, prevalence of waterborne diseases, pollution from poor waste management and improper damping; (e) destruction of wetlands that are natural breeding and feeding grounds for fish and bird species; (f) water hyacinth (Eichornia crassipes); and (g) deficient property rights and institutions. Diminished Lake Tana waters and biodiversity loss negatively impacts livelihoods and food security of surrounding communities and the country at large, ecosystem services and functions provided by the Lake; unique cultural heritage and ancient monasteries and downstream riparian countries, Sudan and Egypt heightening tensions and conflicts.
Conclusions and recommendation
The paper highlights the urgent need for a holistic and coordinated local and global investment action to conserve the Lake's biodiversity and ecosystem based on best practices; greater cross-sectoral understanding of threats and impacts and the critical importance of conservation - that conservation enhances economic growth and societal wellbeing rather than derailing them. Investment in conservation combined with stronger policies and institutions would help build regional peace; ensure sustainable livelihoods; improve food security; save unique species from extinction; restore the country’s cultural heritage - a major foreign exchange earner and help the country achieve its development goals of economic growth and transformation.
Integrating water and energy bills to construct the wastewater infrastructure

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Keywords
wastewater, finance, energy, tariff, cost

Highlights
Wastewater treatment in Tangier is a paramount objective for environmental protection and tourism reasons. However, only half of sanitation needs are covered by the rate payers, requiring local authorities to develop a specific tariff scheme to cover the remaining costs. This puts the ecosystems services at risk.

Introduction and objectives
In 2002, Tangier wastewater from over a million inhabitants was discharged into the natural environment without treatment and the sanitation service coverage rate was 79%, with unsustainable impacts on tourism and environment. At this time, Tangier entrusted the construction and operations for the distribution of drinking water, electricity and liquid sanitation services to Amendis (Veolia Morocco) for 25 years. The key requests of the contract are more widespread access to wastewater services and decreased pollution of the coastline. The contract objectives request the utility to be self-financing and to maintain a financial balance of the outsourced management.

Methodology approach
The master planning studies for liquid sanitation identified the sewage infrastructure needed to restore the natural environment and minimize the pressure on resources through reuse of treated wastewater. The contract provides that the tariff is set by the authorities, and that the investment program is covered by bills and self-financing generated by the operation of the services. Since the wastewater activity alone does not cover all its costs, the authorities decided to use the integration of the water and electricity activities under one contracting mechanism to cover this financing gap.

Analysis and results
The contract sales-revenue splits 78% from electricity, 18% from water, and 4% from wastewater management, whereas the latter represents 49% of the 640 million Euros investments program over the 25 years of the contract. However the wastewater management activity alone only generates 172 million Euros, including 42 million Euros in cash flow and 130 million Euros from customer bills, for investment.

The financing gap of 143 million Euros is covered by the surplus generated by the electricity activity (92%), and to a lesser extent, by the drinking water bill. This deliberate choice by local authorities, validated by regulators, to set an electricity tariff which allows this financial transfer, was paramount to clean the coastline.

The plan has attained its final phase with the completion of a pre-treatment station with outfall at sea, the extension of the treatment plant with tertiary treatment, 50 pumping stations and 1,700 km of infrastructure and distribution networks. The sanitation service rate reached 99% coverage at the end of 2017. Projects for the reuse of treated water for the watering of golf courses and green spaces are also operational, allowing an additional saving of drinking water.
Conclusions and recommendation
In Tangier, an affordable approach to the preservation of the aquatic environment and access to sanitation services is being achieved thanks to the integration of water and electricity services within the framework of a multi-service contract. This contract currently meets its objectives of greater access to liquid sanitation services and reduced discharges to the natural environment, thus enhancing local ecosystems. This solution may apply to other regions where sanitation infrastructure is not sufficiently developed and a lack of access to liquid sanitation is combined with insufficient revenues.
Investing in aquatic ecosystems and biodiversity: Beginning from schools

Presenting Author: Ms. Neetika Sharma, Government High School, Mahin Sarkar, Jammu, India

Keywords
Investing in aquatic ecosystems, Biodiversity, Schools, Fresh water, Sustainable human development

Highlights
Study conducted in four schools showed that, on an average, 92%, 86% and 78% of the students, undergoing courses in aquatic-ecosystem management, gained very good knowledge of awareness, understanding and appreciation of the ecosystem management and, could become future preservers of ecosystem and biodiversity. Investment should begin from schools.

Introduction and objectives
Freshwater ecosystems are important for global biodiversity and provide essential ecosystem services. These ecosystems are vulnerable to the impacts of climate change, which may trigger irreversible regime shifts due to which biodiversity and ecosystem services may be lost. Freshwater ecosystems, including streams, rivers, lakes, riparian areas, and other wetlands, are highly vulnerable to stressors such as eutrophication, species invasion, land-use change, and increasing temperatures. Worst-case scenarios depict an erosion of resilience of freshwater ecosystems, affecting the ecosystem services in the future. I studied how schools can raise nurseries of future budding water-ecosystem-preservers and decision-makers in natural resources management.

Methodology approach
Four schools were selected for the study. Two batches, comprising 50 boys and 50 girls each, were selected from each school. Curriculum on water ecosystem management was introduced in two schools while the students from other two schools were not taught this syllabus. The curriculum included courses on aquatic ecosystem management, including fresh water with main emphasis on awareness, understanding, appreciation, evaluation and solution. Greater emphasis was placed on the improved management of blue (harvestable) and green (soil water, plant use) water, and this applied at all scales of water management. Environmental, economic, and social dimensions of sustainability were included.

Analysis and results
On an average, 92%, 86% and 78% of the students, undergoing courses in water ecosystem management, had very good knowledge of awareness, understanding and appreciation of the water ecosystem management compared to 14%, 16% and 18% of those students who did not undergo the course, respectively. Evaluation of the project showed that the water-use efficiency has increased in the area where curriculum on water ecosystem management was introduced by increased demand management, improved infrastructure, improved water productivity of agriculture, minimizing the water intensity (embodied water) of goods and services, concentrating food production in areas of high productivity, and planning for climate change. At the local level, people are becoming more self-sufficient by harvesting rainwater and reducing use of mains water. Human impact on ecosystem services was managed by approach is based largely on information gained and management of consumption of resources. Resource management was applied at many scales, from economic sectors like agriculture, to work organizations, the consumption patterns of households and individuals and to the resource demands of individual services. The underlying driver of direct human impacts on the environment is human consumption which was reduced by making the full cycle of production, use and disposal more sustainable.
Conclusions and recommendation

For humans, sustainability is the long-term maintenance of wellbeing, which has environmental, economic, and social dimensions, and encompasses the concept of stewardship, the responsible management of resource use. One of the most promising methods of reaching such a state of sustainability is through technology, which provides the means for modifying the natural environment for human purposes and a wide range of consumer products and services. With human interventions, the ecosystems are under extreme pressure, resulting in deteriorated ecosystem services. It is high time that educating the people about the sustainable water ecosystem management, is started from their childhood in schools.
Investing in free-flowing rivers: Addressing the development challenge

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Keywords
river connectivity, infrastructure, basin planning, species migration, natural flows

Highlights
- River connectivity and free-flowing rivers have declined and will further decline with planned infrastructure
- Only 36% of long rivers (>1000 km) remain free-flowing and only 23% free-flowing and connected to the ocean
- Results of this study, including new connectivity metrics and methods, provide critical inputs for more sustainable river basin

Introduction and objectives
Rivers are ‘arteries of the Earth’, critical to sustaining aquatic ecosystems and many societal and economic services. However, many benefits, like sediment supply to deltas, fisheries and biodiversity, require free-flowing river networks, while others, like water supply and hydropower, require hard infrastructure that disrupts river connectivity and ecosystem processes. Loss of river connectivity has been associated with loss of freshwater species in the US and Europe where rates of species extinctions are particularly acute. Safeguarding and restoring river connectivity and free-flowing rivers (FFRs) is a grand management challenge, made urgent by accelerated hydropower development and unprecedented declines in freshwater biodiversity.

Methodology approach
We define FFRs as rivers where natural aquatic ecosystem functions and services are largely unaffected by changes to fluvial connectivity allowing an unobstructed exchange of material, species and energy. We analyzed five main pressures that affect river connectivity and for which global data were available: (a) river fragmentation; (b) flow regulation; (c) water consumption; (d) road construction; and (e) urbanization for all river reaches (8.5 million reaches, average 4.2 km long); combined these indicators into a connectivity status index (CSI); and evaluated FFRs to be rivers which maintained a CSI level of 95% along their length from source to outlet.

Analysis and results
Long (>1,000 km) rivers are the most threatened with only 36% remaining free-flowing and only 23% free-flowing and connected to the ocean. With buildout of planned large dams, these numbers drop further to only 24% of long rivers remaining free-flowing and 18% free-flowing and connected to the ocean. These results reinforce the urgent imperative for concerted global and national strategies to maintain and restore river connectivity and FFRs around the world if we are to sustain freshwater species, river ecosystems and the services that they provide. We recommend three concrete actions: the incorporation of river connectivity metrics in dam and energy planning with the aim to maintain or restore connected networks of FFRs; reoperation of infrastructure where it exists to mimic the natural flow regime; and strategic removal of aging infrastructure to reconnect rivers and floodplains. The global results are limited by the accuracy of global data inputs; however, the methods and metrics can and are being applied in specific basins using better local data. Application at the basin scale and incorporation into ongoing planning processes are helping to elucidate trade-offs in development planning and finding more sustainable options that deliver across a range of SDGs.
Conclusions and recommendation
Concerted and coordinated action by a range of actors is required to deliver across the SDGs while simultaneously improving the state of freshwater biodiversity and meeting CBD targets. Economic and development planning agencies, environmental authorities, hydropower developers and engineering firms, civil society and academia, financial institutions and water resource managers each have a unique role and can contribute to ensuring that connected river networks and associated services are maintained or restored.
Making freshwater biodiversity in the Americas count: Safeguarding water security

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Keywords
water governance, watershed services, ecosystem protection and restoration, societal values, watershed conservation

Highlights
• Policy-relevant knowledge of the contribution of freshwater biodiversity and ecosystem services to the economy, water security and well-being of people in the Americas
• Identification of governance opportunities with high potential to guarantee water security and ecosystem’s health
• Lessons learned from a science-policy assessment and its implications for freshwater systems conservation

Introduction and objectives
The American continent has the largest proportion of freshwater resources, extent of rainforest, extensive wilderness areas and is home to outstanding biodiversity. However, the contribution of such extraordinary biodiversity to human well-being has been largely unexplored, despite their accelerated loss and degradation. Our objective is to provide policy-relevant knowledge by evaluating the contribution of freshwater biodiversity and ecosystem services to the economy, water security and well-being of people in the Americas. We also aim to identify opportunities for improving environmental governance, addressing linkages between land and water resources, which are strongly connected to the achievement of Aichi targets and SDGs.

Methodology approach
The first regional assessment from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) evaluated the current state of knowledge about biodiversity and ecosystem services in the American continent. We made a literature-based synthesis to expand the major initial findings of this assessment related to freshwater biodiversity and the role of ecosystem services in supporting economies, livelihoods and water security. This synthesis focused on responding policy-relevant questions posed by decision makers, essential for unleashing opportunities that can guarantee water security and ecosystem’s health, working towards improved governance and the protection and sustainable use of freshwater systems in the Americas.

Analysis and results
Nature in the Americas underpins regulating functions highly relevant to environmental processes that are essential to human water security. Forests and wetlands are the ecosystems most recognized for their role in the regulation of freshwater supplies. Conserved areas are key for providing drinking water for several cities in the Americas, and wetlands deliver well-documented benefits in waste treatment, acting as natural water purification plants. The flows emanating from freshwater ecosystems are also important for energy production. However, these benefits have been undervalued and severely threatened by extractive uses and
exacerbated by climate change. Severe water scarcity is already experienced in several urban areas across the Americas. Furthermore, the importance of this region as commodity producer places additional pressure on freshwater resources for irrigation. Increasing agricultural production has resulted in high nutrient loading to rivers and streams, as well increased use of agrochemicals, both with negative consequences for ecosystem function and water quality. To address these water security challenges, policies such as protected areas, watershed protection initiatives, offset and compensation and ecosystem restoration, have been implemented and have provided several opportunities that benefit societies. However, prioritizing societal benefits to meet human water security can also bring environmental degradation and costly remediation.

Conclusions and recommendation
Fresh water resources in the Americas enable economic growth and sustain livelihoods of over a billion people, yet they are poorly recognized or quantified. A broader view of the importance of freshwater systems that account for societal challenges is required. Protected areas provide tangible benefits such as clean drinking water and associated watershed services, but if they are not designed carefully, these benefits may come at the cost of displacing local communities. Successful policies to protect freshwater systems need to account for how societies value nature, negotiate interests, prioritize problems and find solutions that respect social, institutional and environmental settings.
Private sector engagement with suppliers to improve water and ecosystems

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Keywords
Agriculture, Supply Chain, Water, Ecosystems, Tools

Highlights
- Case studies across a range of leading companies and sectors highlight best practice in collective action through supply chain engagement.
- User-friendly web-based tools provide practical and effective mechanisms for managing complex information and tracking progress.
- All parties benefit from improvements to ecosystems by reducing water-related risks.

Introduction and objectives
Expansion of agricultural water use is contributing to widespread impacts on ecosystems. Agricultural producers and companies with supply chains that rely on agricultural products are facing growing business risks. Response actions that companies can undertake to mitigate these risks range from economic hedging mechanisms to enhancing water supplies in the value chain (Larson, 2012). Key challenges for companies with large global supply chains include how to most effectively engage with suppliers, measure improvements and develop metrics to track progress. This paper describes case studies and tools that illustrate best practices to address these challenges across a range of business sectors.

Methodology approach
Over the past decade, the authors and colleagues have supported numerous global corporations and non-governmental organizations in developing and implementing water stewardship strategies. This study was designed to document current ‘best practice’ related to engagement in the agricultural supply chain, based on this work and related initiatives. The key research questions include: What practices are currently being implemented, what processes are followed, and how effective are they? How have information, communication and technology (ICT) developments been applied to help facilitate supply chain engagement? The research framework involved independent research and interviews with water leaders in the corporate and NGO communities.

Analysis and results
Corporate water stewardship to date has focused primarily on understanding and reducing water use in direct operations. Some companies are also ‘balancing’ water consumption through engagement with local stakeholders to support conservation projects in source watersheds (Bass and Larson, 2016). Leading companies understand the importance of going beyond direct operations to contribute to more sustainable management of shared freshwater resources in the supply chain, but they can be challenged by how to best engage where they do not have direct control. The complexity of global supply chains is a confounding factor. Sustainable-sourcing practices typically include procurement using supplier codes of conduct and third-party sustainability standards. Some businesses are engaging directly with producers to gather data and seek demonstration of continuous improvement based on various metrics. Recent years have seen an increasing number of NGO-led platforms and collaborations focused on sustainability in agricultural supply chains, providing tools and resources and opportunity for commodity-specific collective action. These and other examples of supplier engagement will be highlighted through case studies.
**Conclusions and recommendation**

The scope and scale of supply chain engagement varies as much as companies vary in terms of products, geographic location, level in the supply chain, and corporate culture. The research conducted as part of this study does not represent a comprehensive review, rather it highlights notable examples of best practice in agricultural supply chain engagement. The study findings can help define appropriate approaches for engagement, and suggest opportunities for other companies to consider. Examining these successful case study examples is important because pre-competitive sharing of successes and lessons learned can help foster more widespread adoption of engagement practices.
Understanding freshwater biodiversity and aquatic systems threats for enhanced decision-making

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Keywords
industry,biodiversity,ecosystems,water management,stewardship

Highlights
Demonstrate the Integrated Biodiversity Assessment Tool (IBAT) freshwater functionality and explain how it can be used by industrial and development projects to evaluate site level freshwater biodiversity risks and understand species' threats at a watershed scale.
Share case studies that will show how IBAT application has improved conservation outcomes, protected ecosystems

Introduction and objectives
This seminar will demonstrate application of the Integrated Biodiversity Assessment Tool (IBAT) fresh water functionality. This functionality enables users including industry, governments, conservation organizations, and academics, to screen for existing stressors to freshwater biodiversity and ecosystems in a watershed. This information is critical to making enhanced environmental management decisions to protect ecosystems and improving conservation outcomes through protection of sensitive ecological. Additional objectives will be to:
• Promote broader uptake of the IBAT as a tool that helps better inform decision-making with respect to sensitive ecological resources management.
• Share best practices and learnings from industry and an NGO.

Methodology approach
Recently, the IUCN Red List of Threatened Species data was transferred to a new sub-basin system (HydroBASINS) allowing IBAT queries on freshwater species from upstream and downstream of a site of interest, providing better understanding of threats and impacts that radiate out from point sources over large distances. Pilot applications of the enhanced IBAT functionality were conducted at three global Chevron locations. The output was refined based on the pilots’ lessons learned. This tool is the result of the Chevron and Conservation International collaboration, focused on advancing science, tools and practices for managing ecological and social risks in the development

Analysis and results
IBAT can be used to identify specific existing threats to freshwater ecosystems, informing management decisions by industry, governments, NGOs and others. The technical enhancements in the IBAT tool added functionality for users to be able to receive a report that:
• Has HydroBASINS as the data base layer
• Shows species upstream and downstream according to a project site
• Presents the IUCN Red List categories, degree of endemism and migratory status of these species
• Shows the protected areas within the same query
• Allows users to select any distance from a site they chose
• Species and protected areas results can be presented according to basin with the option to have results displayed either separately, cumulative or by basin.
Conclusions and recommendation

International Oil Companies (IOCs) including Chevron and BP have used this tool in early project assessments and will share learnings from pilots.

Key findings included:

- The collaboration between end users (IOCs), data providers (IUCN) and NGO’s (CI) resulted in functional enhancement of the tool aiding in decision making for mitigation actions.
- Transparency of data origination, which enables users to determine the need for additional baseline studies.
- The information from the list of threatened species from IUCN Red List, provided important insight on biodiversity and ecosystems risks at the watershed level.
- Supplemental data (experts' opinion) is important to validate findings.
Water community providers, ecosystems and adaptation in rural Central America

Presenting Author: Dr. Roger Madrigal-Ballestero, EfD/CATIE, Costa Rica

Keywords
Development, watersheds, ecosystem services, pricing, ecosystem-based adaptation

Highlights
• The performance of most water community providers in rural Central America is deficient and hinders development, particularly in drought prone areas
• Ecosystems services condition water delivery and adaptive capacity to climate change and variability
• Governance and financial aspects are critical to ecosystems restoration and improvement of performance of water providers

Introduction and objectives
Despite successful improvements in drinking water access, safe water is still not easily accessible to many households in poor and rural areas of Central America. Community-based drinking water organizations (CWO) are the most important providers in these regions. However, their performance do not contribute to foster development and adaptation to climate change. Degradation in ecosystems, poor governance and financial burdens limit the capacities of CWO to contribute to human well-being. We use primary data collected from CWO located in poor regions of Guatemala, Nicaragua and Costa Rica to assess these factors and discuss policy options for improvement.

Methodology approach
We carried out statistical analysis of survey-based and GIS data, collected from 160 water community organizations and 7,000 households located in the driest regions of Guatemala, Nicaragua and Costa Rica. We use primary data on the governance of CWO (e.g. rules, financial characteristics, human capital of the water board, relationship with external actors, performance indicators), water use at the household level and ecosystem variables (e.g. land uses, temperature, precipitation). We fully considered the effect of climatic and environmental variables on performance of CWO and the emergence of certain institutional features of CWO.

Analysis and results
The vast majority of literature on the performance of CWO largely ignores the effect of ecosystem services, coupled with governance, on performance. Our results constitutes a pioneer effort to bridge this gap. We found that differences in ecosystem attributes affect water treatment costs of CWO and coping strategies with droughts at the household level. On the other hand, controlling water demand is critical for preparedness against droughts. For this, one of the most important strategies a CWO should take is adopting volumetric pricing. Nevertheless, setting the incentives and overcoming obstacles that limit this critical change is necessary to scale up results. Promoting the financial health of CWO through improved cost-recovery practices is another important low-regret solution for building drought preparedness. Adaptation to drier conditions will need substantial modifications in physical infrastructure as well as green investments on watersheds, which requires large amounts of capital. Since most CWO are not capable of funding these investments, governments and other key stakeholders should promote sounding financial policies to support these organizations but without undermining local incentives to contribute.
**Conclusions and recommendation**

The vulnerabilities of CWO to climatic and non-climatic threats are intrinsically associated to deterioration of critical ecosystems, poor governance structures and lack of financial resources. Under these conditions, millions of people in rural Central America suffer from unreliable water services affecting their quality of life and development opportunities. Hence, the implementation of low-regret adaptation measures could be an effective strategy to respond simultaneously to generic threats to water provision and to the longstanding development needs. These options include investments in restoration and conservation of essential functions of ecosystems as well as strengthening of local institutions.
Wetworking: A participatory network for wetland conservation

Presenting Author: Prof. Deepthi Wickramasinghe, University of Colombo, Sri Lanka

Keywords
Networking for conservation, sustainable partnerships, wetlands

Highlights
This project addresses the vital need of networking and developing sustainable partnerships among diverse stakeholder groups in conservation of wetlands.

Introduction and objectives
Wetlands provide significant economic, social and cultural benefits. Despite all the services they provide worldwide continue to face many pressures from human activities, and Sri Lanka is no exception. The current programme focuses on the Bolgoda which is the largest natural freshwater lake in the country. Bolgoda wetland is tightly linked with the lives of the communities of the area and hence diverse community / ecosystem interactions exist. One key challenge in conservation management of this ecosystem is the essential need of multi stakeholder approach for collective decision making and action.

Methodology approach
Recognizing the urgent need for conserving this ecosystem and the importance of integrated actions, Sri Lanka Water Partnership initiated ‘a network’ and took a leading role in enhancing efforts to conserve the Bolgoda wetland in active collaboration with different

a) Government sector/ Central Regulators- relevant Divisional Secretariats and Central Environmental Authority, Sri Lanka Land Reclamation and Developmental Corporation
b) Local government (Decentralized regulatory function at local level)
c) School children and teachers
d) Community organizations- NGOs and CBOs in the Bolgoda catchment

All parties were provided a common platform to meet and discuss the issues, challenges and the way forward.

Analysis and results
Most significant outcomes of the ‘wetwork’ – networking for conserving the Bolgoda wetland include, but not limiting to the following:

a) Establishing the links between the regulators/ local government members and community organizations and facilitating discussion on several critical issues
b) Establishment of six new community environmental organizations at the grass root level to protect Bolgoda and getting them registered under the
c) Facilitating community reporting of environmental Issues relating to the wetland to the regulator with written reports on pollution and habitat degradation with photographs as evidence
d) Development of a newsletter with the articles, poems, news items etc submitted by the school children which was then distributed among the schools of the area
e) Development of booklets and posters in local languages for awareness raising
f) Initiation of a research group including university researchers and youth groups.
g) Initiation of links between the regulators and the private sector under their corporate social responsibility programmes targeting integrated conservation measures
Conclusions and recommendation
In this project have demonstrated some measurable benefits of ‘wetwork’ network which has established sustainable partnerships in conserving Bolgoda wetland ecosystem. The network served to bring together stakeholders across many disciplines and backgrounds to share views and ideas while learning from each other and forging new collaborations. The preset project could be a good example of working together of diverse groups towards common objectives of conservation and sustainable development.
Willingness to accept: Enticing landholders into environmental payments schemes

Presenting Author: Mr. Mitchell Kirby, Southern Cross University, Australia
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Keywords
Choice Experiment, Payments for Ecosystem Services, Environmental Policy

Highlights
Willingness to accept ordered choice experiment
Multiple ecosystem service focus: Biodiversity, Carbon, Water and Soil
Policy scenarios for establishing Payments for Ecosystem Services markets in Australia

Introduction and objectives
Payments for ecosystem services (PES) are a phenomenon in natural resource management (NRM). By paying landholders to secure ecosystems, PES have been able to benefit human-wellbeing through 1) securing services, such as water purification and biodiversity, and 2) provide relief to embattled landholders with an additional source of income. Despite their advantage over other NRM approaches, with limited funding available, their success is dependent on identifying an appropriate price that maximises cost effectiveness and increases participation. The objective of this presentation is to identify PES scheme traits that maximise participation and bring additional environmental benefits to society.

Methodology approach
The approach to this experiment involved the implementation of a large-scale online landholder ordered choice experiment across New South Wales, Australia. Targeting landholders with properties greater than one hectare, this experiment asked its respondents to choose between different hypothetical PES schemes. These schemes were made up from the following attributes: ecosystem service focus, pre-scheme requirements, work intensity/inputs required, length of contract, payment mode, and payment amount.

Analysis and results
Returning 1055 responses, the results reveal that the longer/larger certain scheme attributes, such as length of contract and work intensity were, the lower probability of participation was. Whilst higher payments had a positive influence on participation, respondents also showed a preference for participating in carbon management schemes over biodiversity, water and soil schemes. Latent class modelling revealed three landholder segments. Each of these segments responded to the schemes and their attributes in varying ways—in particular payment mode and contract length. Analysis on landholder characteristics determined several elements which drive participation, such as: property ownership, land-use, income, and information seeking behaviours.

Conclusions and recommendation
From the results of this research, this presentation will showcase three policy scenarios appropriate for the cost-effective establishment of PES markets in regional Australia. This will assist public investment into biodiversity, carbon, water and soil protection schemes.
Seminar: Ecosystems in an urbanising world: Challenges and opportunities for symbiosis

ABSTRACT VOLUME

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Seminar: Ecosystems in an urbanising world: Challenges and opportunities for symbiosis

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Accra’s groundwater: A strategic resource for improved (peri-) urban resilience

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Keywords
Groundwater, resilience, urban transition, MAR

Highlights
• For poor urban households, resilience is a matter of ensuring water access from different sources, for different purposes;
• In stressed urban water scenarios, diversification is vital to spread risks and improve preparedness;
• Managed aquifer recharge and groundwater source protection form the backbone of conjunctive use.

Introduction and objectives
With increasing pressure and impacts from population growth, urbanization, climate change, etc., the ecosystem services that aquifers in (peri-) urban areas provide are fundamental as water reservoirs and buffers. Accra and its hinterland exemplify an African city with chronic water shortages, where groundwater resources offer opportunities to improve resilience against recurring droughts and general water insecurity. However, this case study is not a conventional success story. Rather, it shows how flexibility and resilience has decreased due to planners and decision makers focusing single-mindedly on expanded raw water intake from a river, dismissing groundwater as inferior and a transient phase.

Methodology approach
As part of the Unlocking the Potential of Groundwater for the Poor (UPGro) research programme, this paper investigates the role of groundwater as a strategic resource, for households’ coping with inadequate drinking water services, and for a city’s short and long-term planning to improve resilience to water shortage and periods of drought. It builds on a case study of Dodowa, a low-income township on the outskirts of Greater Accra, Ghana. Primary data were collected using a mixed-methods approach, including observations in situ, semi-structured, open-ended interviews with residents, the public water utility, the District Assembly and others, and a survey (n=300).

Analysis and results
The literature highlights the importance of a city leaving behind the idea of being self-supporting on water, and the risks associated with relying heavily on an engineering, technology-driven conceptualization of resilience, pointing instead to how attempts at managing variability to reduce vulnerability may lead to lock-in with large-scale infrastructure such as dams. Further, scholars stress that the ‘water security’ dialogue must be better informed about groundwater, to attain the SDGs. Though groundwater is the major source of drinking water in sub-Saharan Africa, its ‘invisible’ character does not easily lend itself to inform policy for the building of resilience. The demonstrated benefits of managed aquifer recharge are key to reduce a city’s vulnerability to and impact from water insecurity.

This study finds that the groundwater dependence in Greater Accra holds important transformation insights and provides lessons for planners and decision makers to re-think the business as usual-approach. Better coping preparedness can be modelled on recognizing how end-users respond to poor piped water supply as well as to other types of changes and sudden events. The longevity of groundwater resources as part of a natural system must be governed in combination with human systems for allocation and conservation decisions.
Conclusions and recommendation
For end-users, particularly poor urban households, resilience is an every-day matter of ensuring access from different sources, for different purposes, while attention to drinking water safety is falling behind. Increasing needs for drinking water safety call attention to contextually fit groundwater treatment methods. Planners and decision makers should take their cue from how households have developed coping mechanisms by diversifying, and move away from the focus on large infrastructure and centralized water supply solutions. Conjunctive use, managed aquifer recharge, and suitable treatment measures are vital to make groundwater a strategic resource on the urban agenda.
Developing urban water ecosystem sustainability indicators: Water ecosystem health assessment

Presenting Author: Dr. Uttam C. Sharma, Centre for Natural Resources Management, India

Keywords
Urban water ecosystem, Sustainability indicators, Health assessment, planning and management, Jammu city

Highlights
Competing water demands impose difficult allocation decisions and limit the expansion of sectors critical to sustainable development of cities. Disruption of ecosystems through unabated urbanization undermines the environment’s capacity. Urban water ecosystems indicators developed for health assessment of Jammu city of India helped in judicious planning and its sustainable growth.

Introduction and objectives
Indicators are tools of information, which summarize important properties, visualize phenomena of interest, quantify trends and communicate them to relevant target groups. Urban water ecosystems (UWE) perform functions like water supply for production and cleaning, removal of fecal matter, handling of wastewater, drinking water provision, prevention of flooding by drainage water etc. Rapid urbanization in and around Jammu city of India face a range of pressures including unplanned growth and unmet demand for basic services, as well as increased water consumption, waste generation and water discharge. The study was undertaken to assess UWE status and improve it for better services.

Methodology approach
The study place is the city of Jammu city of India having a population of about 1.1 million. The major factors considered for UWE indicators were; status (source and quantity of water bodies), quality (extent of pollution), dimensions of sustainability (environment, society and economy), economic accounting (environmental good as and services are valuated in monetary terms), biophysical (natural resources required to perform certain economic activity or to sustain a national economy), resource and material (stocks and flow paths of resource/material along all the uses into certain boundary), and pressure (causal chain of a particular effect considered as negative for sustainability).

Analysis and results
Due to scanty rainfall and its biophysical setting, the Jammu city is prone to water shortages as most of the rainwater goes down the drain without proper usage. By developing UWE norms, five major causes of worry solved for Jammu are; system boundaries, objectives, time frame of projects, external pressure and, needs and interest of stakeholders. The boundary of a system under analysis will significantly influence the final result of an assessment and the solution devised. Most of system boundaries are focused on the main infrastructure. However, such approach might not represent fully the water flow in the city. When city areas are not covered or there are problems of low maintenance or high tariffs, urban dwellers organize complex means to acquire water, dispose fecal matter and deal with floods. Other water sources, practices and other systems were then developed. It means that design and selection of indicators become a space where those differences need to be settled. Persistent poverty, inequitable access to water supply and sanitation services, inadequate financing, and deficient information about the state of water resources, their use and management impose further constraints on water resources management and its ability to help achieve sustainable development objectives.
Conclusions and recommendation

Water ecosystem services are a crucial part of sustainable urban development. They contribute to resilience against disasters, regulate temperature, improve food and water security, absorb pollution, contribute to livelihoods and addressing poverty. The strong linkages between urban quality of life and how cities use and manage natural resources becomes essential in having integrated approaches to sustainable urban development. If managed well, urbanization can create employment and prosperity, and become a central driver for eradicating extreme poverty and for strengthening social inclusion. Development of UWE norms for Jammu city has helped in proper planning and judicious management of resources.
Floods find their own path: A case study from Kelani

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Keywords
wetlands, flood risk reduction, sustainable development

Highlights
Wetlands provide significant ecosystem services in flood resilience. When wetland habitats are filled up and converted to other uses with increased impervious surfaces and loss of connectivity, risk of flood damage increases. Thus, wetland conservation should be incorporated in sustainable development agendas specially in urban management.

Introduction and objectives
Wetlands act as natural infrastructure in flood disaster mitigation with no cost of building and maintenance. Nevertheless, in many urban areas wetland habitats are rapidly shrinking due to population growth and expansion of developmental activities. Kelani river is a key water body in Sri Lanka which flows through the highly populated Colombo district. Substantial and rising impacts of river floods have caused many socioeconomic and environmental implications in the recent past. In this study, we hypothesized that the land use changes, specially shrinking of wetland habitats in the area, has contributed to flood damage.

Methodology approach
This study was carried out in Kolonnawa and Kaduwela areas in the lower reaches of the Kelani river basin to determine the land use changes in the previous four decades up to 2016. Several filed visits were made for ground level verifications and flood damage data were obtained from local authorities. The effects of land use features on flood occurrence have been determined by using GIS and remote sensing. Areas represented by major land use types (including built environment, home gardens, wetlands and marshes) were studied and the change of each category was calculated by using geometric calculations.

Analysis and results
The current study reveals the following significant facts:

a) The study area has undergone tremendous changes in relation to transformation of landscape from natural (wetlands, marshes, bare land) to built up areas (buildings, roads).

b) Nearly 50% of the natural and man-made wetlands has disappeared due to encroachment, filling and conversion to built up areas during the last 4 decades and connectivity between many such habitats too were lost.

c) Most interestingly, in the last two decades when the river flooded, water has flown to all the areas where wetlands were once existed and at present under built up.

d) The results demonstrate that filling up of wetlands has contributed to increased flood damage.

Conclusions and recommendation
The results of the present study illustrate the risks of filling up, encroaching and building over wetlands in the low elevation areas. It also highlights the benefits of maintaining healthy wetlands which can be readily included in developmental plans to enhance urban resilience to flood disasters. Thus, the findings of this research provide impetus for integration of wetland management in urban landscape planning to enhance natural defenses against flood disasters.
Integrated approach for blue/green infrastructure management in urban areas

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Keywords
Blue/Green Infrastructure, Citizen Science, Ecosystem Services, Integrated Water Management

Highlights
A global citizen science programme in 18 major cities, addressing the twin challenges of urbanisation and climate change, provides us the possibility to show how a participated and integrated approach to aquatic ecosystem management has benefits on individual and community well-being, livelihoods, education, social interaction and regulatory capacity.

Introduction and objectives
Climate change and urbanisation are global trends that have linked causes and effects. As the world’s population becomes urban, new approaches are required that follow a more integrated and participated process to address both these causes and their effects. We show the results of a global citizen science programme supporting innovative and integrated urban design and management in Asia, Europe, Americas and Middle East. We will explore the benefits and costs of creating more participative approaches on urban ecosystem management and policy.

Methodology approach
Citizen scientists are working with local scientists, policy and planning institutes to explore novel ecosystem approaches to urban design, planning and the creation of more sustainable cities through an ecosystem based approach. We use an interdisciplinary methods to quantify and qualify ecosystem services provided by urban blue and green infrastructure for the local and wider urban community. Each project brings together private partners, citizens, policy and planning institutes and leading scientific partners to address the multiple and far ranging aspects of sustainable cities. Working across climate, cultural and socio-economic ranges allows for new insights into the possibilities of urban sustainability.

Analysis and results
Our preliminary results indicate that this participative approach has benefits for the scientific community, regulatory agencies, policy institutes and planning agencies, and most importantly, on the participants themselves. Through the efforts of trained and enthusiastic citizen scientists, scientists are shown to have an increased capacity to identify key trends in urban ecosystem dynamics, with an average return on time invested in training of nearly 4:1. By increasing both spatial and temporal coverage of key ecosystem services indicators, scientists can better support innovative ecosystem based approaches to key urban challenged related to flooding and drought, nutrient and carbon dynamics and urban heat island effects. These activities are conducted with the support of policy and planning agencies as well as regulatory partners. Efforts by citizen scientists are shown to support regulatory agencies, increasing their capacity to gather fundamental ecosystem information, across a more complete range of ecosystems and with an increased tempestivity with regard to extreme events. For planners, the participation is show to increase citizen scientist’s awareness of urban tipping points and their support for more sustainable policy and planning approaches. Participants show an increase in engagement with local actors and positive benefits on their personal and institutional sustainability.
Conclusions and recommendation

This programme and its sister projects allow us to analyse the costs and benefits of recruiting, training and engaging citizen scientists to promote ecosystem approaches and demonstrate their benefits to urban management and planning. Increasing the participation of this growing community of urbanites in the study and stewardship of their local environment is a major opportunity to promote more integrated approaches to urban management, basic to meeting the SDGs.
Integrating green infrastructure in dense cities of the global south

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Keywords
Green infrastructure, Human Settlements, Water treatment, Drainage, Participatory planning

Highlights
The research analyses green infrastructure designs for drainage and wastewater management. It focuses on low-income settlements, with Latin American and African case studies, and thereby emphasises poorly understood planning challenges in these contexts. It particularly discusses participatory tools to consider residents’ needs, juxtaposed to governance systems for green infrastructure development.

Introduction and objectives
Green infrastructure has attracted global interest for implementation of nature-based solutions in cities. This research aims to take the concept of green infrastructure a step forward. It recognises that the pursuit of greening strategies may conflict with other urban development priorities, including that of poverty reduction. It discusses integration in low-income, dense settlement contexts, thereby bridging ecological and social agendas for resilient cities in the Global South.

The objectives are to: 1) evaluate green infrastructure design techniques for drainage and wastewater management at community scale; 2) understand participatory practices enabling to better consider spatial tensions, and to engage with stakeholders.

Methodology approach
Although still largely misunderstood, challenges of ecosystem development in cities greatly lie in spatial planning and social inclusion. Adopting a political ecology approach, the research explores ways to break exclusionary patterns in urban planning. It evaluates urban green infrastructure practices through the following steps:

- Review case studies of green infrastructure implementation approaches for low-income settlements in São Paulo (Brazil) and Durban (South Africa);
- Analyse designs optimising the use of space while improving drainage and wastewater management through the concept of slum networking;
- Analyse engagement with slum dwellers for green infrastructure design and implementation based on participatory methods.

Analysis and results
From an engineering perspective, the review highlights the lack of research conducted on green infrastructure in tropical climates. In urban planning, it shows poor empirical evidence has been gathered on integration for the benefit of slums dwellers. This also emphasises the lack of institutional capacity for development and planning of informal settlements.

The São Paulo case study demonstrates that comprehensive GIS data analyses and mapping enable to meet design objectives, including that of water efficiency and flood mitigation, while considering socio-economic factors. A range of technical and design expertise requiring interdisciplinary approaches have led to the design of a network of solutions including permeable pavements, rain strips and bioswales which are analysed as implementable in favelas. Further engagement is however required to comprehensively integrate residents’ opinions on the extent to which these meet their needs.

The case of Durban which aims to implement closed-loop water systems using wastewater for urban agriculture emphasises the value of community engagement to capture residents’ perceptions, attitudes and knowledge of the local environment. Potential for urban farming through such techniques was validated.
through focus group discussions were participants responded positively, recognising space constraints but identifying value in income revenue at both individual and communal scale.

**Conclusions and recommendation**

In order to overcome the challenges of balancing compactness and ecosystem development while meeting populations’ demands in cities, tensions between social and ecological agendas over spatial planning must be better considered. The research participates in building a case study database to inform future practice. Participatory approaches are recognised in NUA as essential for just urban planning. Aligning with this purpose, the research shows mapping stands as a tool to contest, engage and include. If green infrastructure must lead to ‘win-win solutions’, then its design and implementation must consider these factors, in a manner it is adapted to local interests.
Integrating land use and water management planning with multicriteria analysis

Presenting Author: Mr. Homero Castanier, Water and Sanitation Utility of the City of Quito, Ecuador

Keywords
Land, water, ecosystem, integration, planning

Highlights
Due to current pressures of population growth and urbanization is urgent the need of integrating land use and water resources planning with an ecosystem approach. This integration is effective by the application of a Multicriteria Analysis (MCA). The results were applied by the stakeholders in plans for the city of Quito.

Introduction and objectives
The pressures of population growth and urbanization are urging attention to the relationship between where and how people live and the water they need. Strategies are arising to integrate land use and water resources planning that will allow decision making based on the appropriate connections. The aim of this work is the design and application of a Multi-Criteria Analysis (MCA) model that allows the qualification of key interacting factors and elements for water management and land use planning under an ecosystems framework, determining the levels of relevance of the integration categories in order they should be given the corresponding consideration.

Methodology approach
This study has a qualitative and quantitative approach, starting with the definition of land use and water resources integration categories and the criteria and subcriteria for valuing them. The ecosystem based criteria, as the required or existing information and plans, and socioeconomic and environmental feasibility, reflect the values associated with the consequences of each water and land use integration categories, as water supply assessment and development, regional structures, and growth management. Once the integration categories and the criteria have been defined, weights and scores are assigned to derive overall values and ranking by a MCA, that includes a sensitivity analysis.

Analysis and results
The integrated consideration of water resources and land use subsystems with an ecosystem approach contributes to sustainable development and water sustainability, identifying key variables of the subsystems that have to be given prioritized attention in order to reach an effective integration, assuring these elements are not left out or would be given minor attention. With the large number of elements considered, a large number of combinations of potential management actions is possible, being fundamental the application of a multi criteria decision making tool.

In the MCA model applied to prioritize the strategic components of water and land use integration categories for the case of the Metropolitan District of Quito, the scores obtained by valuing the expected performance of each integration component against the criteria, represent their level of relevance according to the corresponding scores. The results of ranking land and water integration categories for Quito are: 1) Water Supply Assessment/1580. 2) Water Supply Development/1547. 3) Regional Structures/1448. 4) Comprehensive Planning Efforts/1410. 5) Growth Management and Densification/1323. 6) Rate Structures/1319. 7) Education/1272. 8) Resource Use Efficiency/1021. The results of the sensitivity analysis carried out demonstrate that the structure of the model is sensitive even to minor variations of input values.
Conclusions and recommendation

The ranking of land and water integration categories according to the corresponding scores of the MCA application, determines the relevance of the integration components. Since all the site specific water and land use integration categories must be considered when formulating land use plans under an ecosystem framework, a MCA is an adequate tool to determine their specific level of relevance based on the assigned values. The application of the model to the city of Quito allows the optimization of technical and financial resources and set priorities related to the timely implementation of water management actions when planning for land use.
Is really ecosystem development hand in hand with urbanization?

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Keywords
Urban ecosystems, Development, Hesitant decision-making, Analytic hierarchy process

Highlights
• Serbian City of Novi Sad is experiencing problems in managing its ecosystems.
• Urban ecosystems are affected by inadequate institutional organization and societal behavior due to inadequate distribution of fresh water to residents.
• Participative decision-making framework is required to motivate residents to work hand in hand with institutions.

Introduction and objectives
Green spaces in Novi Sad City (Serbia) provide a variety of physical, psychological, and social benefits to residents. Institutional organization is inadequate for sustainable development of city parks because manageable factors which influence people’s health and wellbeing are not well recognized. Research indicated possible improvements in maintaining parks, distribution of fresh and purification of polluted water, fostering resilience of ecological systems, and reducing and protecting the environment. We developed scoring and aggregation schemes and interpreted experts’ judgments to define priorities in preservation (management) and future investments into green areas.

Methodology approach
Earlier research indicated need to more explicitly relate urban and ecosystem development indicators with management of city parks, i.e. to quantify their mutual impact and trace the road toward synergy. We created participative decision making framework and used hesitant analytic hierarchy process (AHP) methodology to derive priorities of indicators. Such quantification enabled more focused discussion and reaching consensus between experts about recommendations to be given to the city government on how to harmonize urban and ecosystem development. Applied methodology is adequate because it manipulates qualitative and quantitative decision elements, commonly expressed in non-commensurate units.

Analysis and results
It is well known that city parks in multiple aspects influence health and wellbeing in the city and positively impact quality of life of its residents. For instance, urban ecosystems are functionally and directly connected with fresh water availability and distribution, but also connected with less measurable ‘ecological culture’ of citizens and their willingness to organize themselves and participate in societal and political processes important to consolidate (where necessary) and help to harmonize overall urban development. Several decision makers from academia and professional organizations applied hesitant AHP group decision making methodology to recognize impacts of various parameters which influence development of ecosystems within different city areas. Aggregation of derived values indicated that city urbanization is not clearly connected to ecosystems development. Assumption made in this experiment was that hesitant information is allowed. Based on individual hesitancy experience, experts could represent their judgments by several possible values. We used several indices to control consistency degree and consensus degree of decision makers to preserve good control of decision making process. The results are encouraging from methodological point of view, as well as quality of results that can be obtained.
Conclusions and recommendation

Urban ecosystem management is multidisciplinary strategic process requiring use of environmental, economic and social tools flexible (robust) when decisions have to be made in variety of situations and unexpected changes in one or more systems. Our research team searched for more explicit relationship of quantity, quality, and accessibility of green urban areas and showed that responsible urban institutions need to adapt to an overall urban context, but primarily to respect interests of citizens as principal stakeholders. Used hesitant methodology assured flexibility in group decision making. It is theoretically sound and easy to implement for reasonably large group of decision makers.
Let nature do the work in the Stockholm Royal Seaport

Presenting Author: Ms. Christina Wikberger, City of Stockholm, Sweden

Keywords
Ecosystem services, multi-functionality, resilience, climate adaptation, storm water

Highlights
Methods and tools for ecosystem services have been developed and tested in the Stockholm Royal Seaport (SRS), that estimates and studies of ecosystem services as efficient, economical solutions in urban development.

Introduction and objectives
The Stockholm Royal Seaport, SRS, is the largest urban development project in Stockholm with 12,000 new housing units and 35,000 workplaces. The area has an environmental profile and ecosystem services are an important part of the work to create sustainable urban development. One of the strategies of urban development in SRS is to ‘Let nature do the work’. By including the R&D project C/O City – on ecosystem services in city planning, tools have been developed and tested in SRS and also spread to other city development areas in Sweden and around the world.

Methodology approach
Three of society’s biggest challenges ahead are climate change, the reduces biodiversity, and urbanisation. By planning and creating ecosystem services we can reduce the negative impact on cities and their surroundings. The purpose of the research and development project C/O City has been to highlight the value of nature in the city, to create a planning basis, data and tools, and generate concrete solutions that facilitate the work with ecosystem services in city planning. C/O City has its starting point in the work of the City of Stockholm on the sustainable profile of the SRS.

Analysis and results
The work on ecosystem services and the R&D project C/O City in SRS have resulted in tools to reach the project’s ambitious goals and to create a climate-adapted and lush outdoor environment in the area. Methods have been developed, such as the green space index and storm water strategies, and contributed to creating an outdoor environment designed for multi-functionality, such as managing increased rain, balancing local climate, creating pleasant outdoor areas, and reinforcing the ecological connections in the area. Several public enquiries have emphasized the importance of ecosystem services. The Swedish government has decided that by 2018, ‘the importance of biodiversity and ecosystem services should be publicly known and implemented in financial standpoints, political resolutions and all other decisions, where ever relevant and reasonable.’ The Swedish government is also setting up a subsidy for greener cities. The government has allocated 100 million Swedish crowns for 2018, 500 million for 2019 and 550 million for 2020. The subsidy shall promote increase and development of city greenery and ecosystem services in urban environments.

Conclusions and recommendation
Creating sustainable cities also requires planning for green cities where ecosystem services are used to deal with the challenges ahead. Integrate ecosystem services in planning in order to create sustainable cities, and consider the green-blue infrastructure as necessary in the same way as any other infrastructure. Use methods and tools that systemize and quantify work in order to make the ecosystem services visible. All tools and methods require good interaction and a process with the parties concerned. It is in the process of cooperation that you create understanding, where good ideas develop and support is secured.
NAIAD: Nature based solutions in Copenhagen, Rotterdam and Lodz

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Keywords
Disaster Risk Reduction, urban flooding, green and blue infrastructure, resilience, insurance value

Highlights
Co-design and implementation of nature-based solutions (NBS) with involvement of key stakeholders with focus particularly on hybrid blue-green and grey infrastructures aiming to assess insurance value of NBS and build resilience to climate extreme events, illustrated for the cities of Copenhagen, Rotterdam and Lodz

Introduction and objectives
Within the project NAIAD (naiad2020.eu) project, the insurance value of ecosystems for mitigation of water related risks is assessed and tested through the co-design and implementation of nature-based solutions (NBS) with involvement of key stakeholders (including insurers). The objectives are: (1) To provide a robust assessment framework for the testing, data collection and operationalization of NBS; (2) To pilot methodologies in cities (Copenhagen, Rotterdam and Lodz) and co-develop for diverse risk and NBS contexts; (3) To identify and address specific barriers and opportunities for the uptake of NBS and natural assurance schemes policy instruments, business models and innovation

Methodology approach
The city of Copenhagen employs an integrated assessment by a Bayesian Belief Network analysis is performed including input from a dynamic integrated hydrological model. The city of Rotterdam has focus on underground storage and recovery of stormwater runoff to expand the aboveground rainwater retention and save rainwater for irrigation. The city of Lodz focuses on rainwater and river management to cope with the challenge of rehabilitation of 18 rivers to counteract fluvial flooding, to co-create green spaces. All three approaches focus on urban green infrastructure NBS and include methodologies on stakeholder participation, risk perception and economic aspects, including co-benefits.

Analysis and results
The city of Copenhagen presents progress in integrated assessment and employing a Bayesian Belief Network analysis including input from a calibrated dynamic integrated hydrological model (MIKE SHE), set up on a 100 m spatial resolution for the greater Copenhagen area and 10 m resolution for a selected area in the urban part. The role of shallow groundwater in the catchment in general, and as a boundary condition for the urban model is explored. The city of Rotterdam presents the results for the Urban Water Buffer system to be implemented in the Spangen neighbourhood using a local Water Balance Model which will be developed using SEAWAT modelling and Python scripting. The city of Lodz presents progress of developing river management for coping with the challenge of rehabilitation of 18 rivers to counteract fluvial flooding and to co-create green spaces. All three cities present the preliminary results of integration of biophysical modelling, social network analysis and risk perception, system dynamic modelling and economic approaches that support the assessment of the insurance value of NBS in urban context.
Conclusions and recommendation

The anticipated conclusions and recommendations for the three urban Living Solution Labs, Copenhagen, Rotterdam and Lodz, will be based on progress in the development of biophysical modelling, participatory methods, including social network analysis and system dynamics as well as economic assessments to support NBS development and implementation by tailoring such tools to the local environmental, social and legislative conditions. Other outcomes are progress in economic valuation methods, including valuation of co-benefits and development of business models to be developed to empower broader investments in NBS.
Non-sewered sanitation: For the community, for the environment

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Keywords
Urban sanitation, non-sewered sanitation, gender, water quality, ecosystem

Highlights
The purpose of this research is to identify how the laws and policies across five African countries facilitate or hinder the use of non-sewered sanitation in urban communities. Sanitation laws and policies are essential to supporting a healthy community and environment.

Introduction and objectives
This research examines how the law advances or hinders the adoption of non-sewered sanitation (‘NSS’) in urban centers. Sewered sanitation - centralized sanitation made up of miles of costly pipes and a centralized wastewater treatment facility - often does not meet the needs of urban communities, especially low-income communities or informal settlements. National-level laws often fail to provide a comprehensive and implementable framework for sanitation and exclude NSS as an option. Ensuring that urban communities property treat their human waste and create value out of wastewater/sludge protects the health of the citizens and reduces water, soil, and environmental pollution.

Methodology approach
The Center for Water Security and Cooperation, with funding from the Bill and Melinda Gates Foundation, is creating the first pan-African water law platform to understand how laws are impacting and influencing water security across all sectors and jurisdictions within and between each country in Africa. We are collecting, cataloguing, independently analyzing, and critically evaluating collected laws to understand the scope and depth of existing water law frameworks. Given the impact untreated sewage has on water quality and human health, sanitation is a priority focus area. Fecal contaminated soils diminish the vibrancy of communities and ecosystem health.

Analysis and results
Our research begins with an examination of sanitation laws broadly, focusing on the management of domestic and industrial liquid waste (excluding solid waste and drainage). We study how existing laws manage human waste along the sanitation value chain. We also look for the inclusion or exclusion of several additional factors in the law including: vulnerable communities and informal settlements, gender, financing and the user-pay principle, citizen engagement, monitoring and reporting, water quality, rural v. urban, emergencies, data-sharing, institutions, and enforcement. Our preliminary research demonstrates that: (1) countries’ sanitation policies are often limited in breadth and depth, providing limited clarity on what is required and by whom (e.g., non-sewered sanitation construction standards, effluent standards, water quality standards) (2) NSS is often not identified as an option, meaning that low-income communities and informal settlements are not being retrofitted with sanitation services, (3) the roles and responsibilities of responsible institutions are unclear and confusing, and (4) the mandate for making sanitation available to all citizens is weak, unfunded, or set forth with little information on how to actualize the right.
Conclusions and recommendation
Our research illustrates the need for stronger, more comprehensive legal frameworks governing sanitation paired with tools and resources that aid in implementation, enforcement, and periodic review as well as clearly defined institutions. Our conclusions will include a detailed comparison of approaches in the five countries as well as identify shortcomings, gaps, inconsistencies and strengths. Recommendation will highlight the types of provisions which should be included in any sanitation framework so as to best promote ecosystem health and community.
The Canadian experience: Enhancing urban stream habitat and building resilience

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Keywords
Enhancement, natural capital, Canada, urban streams, bioengineering

Highlights
Valuing nature and natural capital is a growing trend in Canada. Urban streams and the ecosystem services they provide have increasingly been acknowledged across many urban areas in Canada. Members of the Canadian Water Resources Association (CWRA) are at the forefront of stream restoration in Canada.

Introduction and objectives
Canada’s experience with urban stream restoration projects, which has involved many members of the Canadian Water Resources Association (CWRA) have enabled communities to enhance natural capital and ecosystem services in an innovative manner to increase ecosystem benefits to society. The objective of this work is to highlight innovations and advances and the prevalence of stream enhancement techniques such as bioengineering and green shores projects across Canada. This presentation will highlight advances in stream and riverbank restoration techniques in Canada and show how enhancement projects can build flood and habitat resilience, offset carbon and increase natural capital and build social awareness.

Methodology approach
The power of CWRA is the network of water resources professionals across Canada. An established network of urban watercourse design professionals across Canada provides examples of stream restoration techniques and success rates from Canada’s abundance of streams and urban watercourses. This identifies gains in habitat resulting from restoration projects and the degree of effectiveness of restoration techniques used to improve natural capital.

Analysis and results
Follow up monitoring of restoration projects including compilation of data is vital to understanding project effectiveness. A strong example to be highlighted is the City of Calgary’s Riparian Monitoring Program and their Bioengineering Demonstration Project. Projects are beginning to be assessed to evaluate the effectiveness of the techniques and determine the net benefits in the urban environment. Techniques can be grouped into categories based on the method of construction and nature and degree of ecosystem degradation. The benefits realized include CO2 uptake and storage, improved air quality, flood and erosion damage reduction, improved recreation and aesthetics and improved water quality. Other benefits include community education, improved hydraulics, reduction is stream temperature, improvements in ecology.

Conclusions and recommendation
Urban stream restoration can provide a multitude of benefits to a community from basic increases in natural capital, net habitat gain and social understanding of the hydrological cycle. This examination of the effectiveness of urban stream restoration techniques has shown that further investment in restoration will enhance natural capital within the community, increase resilience to flooding and improve the social environment in a community. This knowledge can be used to drive further increase in restoration of urban watercourses and ecosystems.
The ecosystem in Gaza Strip between challenges and solutions, Palestine

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Keywords
Gaza Strip, ecosystem, land use

Highlights
Gaza Strip faces big challenges to secure ecosystem. This study focuses on Wadi Gaza and Gaza Beach. Wadi Gaza Nature Reserve is the main natural feature of the Gaza Strip. This study evaluates the ecosystem in Gaza and put the long-term investments and priorities.

Introduction and objectives
Gaza Strip has high growth rate percentage (3.44%). Urbanization area increasing rapidly due high demands on lands. There is severe change in ecosystem in the whole Gaza Strip due to limited water resources, water salinity and using pesticides. These factors have severe impact on ecosystem. The main objectives of study is to evaluate the ecosystem in Wadi Gaza and Gaza Beach and to put the long term solutions to secure ecosystem.

Methodology approach
This study focusses on two zones in Gaza Strip; Wadi Gaza and Gaza Beach. Data collection have been achieved and spatial maps have been developed using data from local authorities in addition of study samples. 100 samples have been measured from different categories and compared it with last 10 years. Scenario in 2030 is predicted.

Analysis and results
More than 150 terrestrial species are in Wadi Gaza affected by climatic changes. There is diversity of flora with 70 species including crop wild-relatives, barley, parsley, Salvia sp, peppermint and sweet basil. Ecosystem and biodiversity is suffering and high changed and loss of habitat due to urban development, pollution, increasing of water salinity and using of pesticides. About 50% of Gaza’s beaches are polluted due pumping untreated sewage into the sea because of Electricity Shortages which is very dangerous to health and safety.

Conclusions and recommendation
This study adapted solutions to secure the ecosystem in Gaza Strip and helps decision makers to put the investments to conserve the ecosystem as followings; increasing the efficiency of Gaza Power Plant and using of renewable energy, improving economic profitability for farmers to keep farms from destroyed. Removing illegal wells to remain the water level reducing the salinity, recharge storm water into ground, improve wastewater networks for surround area of wadi Gaza to avoid reaching of sewage to wadi Gaza. Increasing awareness application of land-use policies. Crop production systems management including soil and water resources, Greenhouse management. Considering Wadi Gaza as protected area and controlled by authority.