Conference Programme

International Conference

Sustainability in the Water-Energy-Food Nexus

19-20 May 2014 in Bonn, Germany

photo © Kibae Park/UN

sponsored & organized by:

GWSP Global Water System Project

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CGIAR Research Program on Water, Land and Ecosystems

Federal Ministry of Education and Research

Conference Programme

Sustainability in the Water-Energy-Food Nexus

Synergies and Tradeoffs: Governance and Tools at various Scales

19-20 May 2014 in Bonn, Germany

ANIK BHADURI
GWSP EXECUTIVE OFFICER
Global Water System Project,
International Project Office,
Bonn, Germany

Welcome to the conference “Sustainability in the Water Energy Food Nexus”.
This conference brings together numerous scientists, scholars, practitioners and policy makers for in-depth discussions on how to identify linkages across key natural resource sectors - water, energy and food - and improve the resource efficiency across sectors so that we can attain a win-win outcome for human well-being as well as environmental sustainability for both current and future generation.
The interlinkages between water, energy and food are most significant and growing in an interconnected world with natural resources beginning to limit. Hence, any efforts to address only one part of a systemic problem by neglecting other inherently interlinked aspects may not lead to sustainable outcomes. In this perspective, policy- and decision-making require a nexus approach that reduces tradeoffs, builds synergies across sectors, and helps to reduce costs and increase benefits for humans and nature compared to independent approaches to the management of water, energy, food and the environment.
Recognizing that there is an urgent need for work along the governance and tool challenges to advance the Water-Energy-Food (W-E-F) nexus at different scales, the conference will address the sustainability in the W-E-F nexus as a key research-for-action initiative through an international policy consultation process to inform, influence, and catalyze action by key actors - including policy makers, non-governmental organizations, the private sector, educators, and researchers. This conference will bring together available information, identify knowledge and action gaps, share lessons on viable instruments and approaches, facilitate networks, and contribute to consensus on priorities for appropriate investment and action by different actors and stakeholders for moving toward action on the W-E-F nexus.
In this conference, special attention will be given to ecosystem-based management approaches and tools to achieve W-E-F nexus and ecosystem sustainability as ecosystems form the basic foundation of the W-E-F nexus with all sectors relying on ecosystem services.
Today we are close to formulating the sustainable development goals (SDGs); and as any concerted action to produce positive outcomes for human and nature requires cross-sectoral collaboration, the nexus approach can be applied in several ways to explore different approaches to SDGs development and implementation. This conference will reflect and explore on such role of the nexus in SDGs.
Before I close, I want to thank all the sponsoring organizations of this conference, the German Federal Ministry of Education and Research (BMBF), the United Nations Environment Programme (UNEP), the German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE) (DIE), the Center for Development Research (ZEF) and the Water Land Ecosystem Program (WLE) of CGIAR for their timely and valuable support, without which it would have been impossible to organize this conference.
I thank you all for attending and bringing your expertise to the conference, and wish you to have a truly memorable and rewarding stay in the Bonn.

Anik Bhaduri

With kind regards,
Anik Bhaduri

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GWSP Senior Advisor, Bonn, Germany

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GWSP Research Associate, Bonn, Germany

Keynote Speakers

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Director of the United Nations University Institute for Water, Environment and Health (UNU-INWEH)

JOSEPH ALCAMO
Professor at the Center for Environmental Systems Research of the University of Kassel, Germany

ALBERT BUTARE
Corporate Executive Officer of the Africa Energy Services Group (AESG)

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Co-Chair of the Global Water System Project (GWSP)

Special Session Convenors

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CGIAR Research Program on Water, Land and Ecosystems (WLE)
German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)
German Federal Ministry for Economic Cooperation and Development (BMZ)
German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
International Institute for Sustainable Development (IISD)
Korea Evironment Institute (KEI)
Stockholm Environment Institute (SEI)
Texas A&M University (TAMU)
United Nations Environment Programme (UNEP)
UN-Water Decade Programme on Capacity Development (UNW-DPC)
United Nations University - Institute for Integrated Management of Material Fluxes and of Resources (UNU-Flores)
World Business Council for Sustainable Development (WBCSD)

Join the discussion online

#WEFNexusConference

CONTENT

CONTENT

photo © Martine Perret/UN

Programme

Monday, May 19th

9:00 – 10:30

PLENARY 1: OPENING PLENARY – ENVIRONMENT AND WELL-BEING / Speakers: *Wilfried Kraus, Achim Steiner, Imme Scholz, Charles Vörösmarty* — **GROUND FLOOR** (Saal Reger)

10:30 – 11:00

COFFEE BREAK » GROUND FLOOR

11:00 – 12:30

PARALLEL SESSIONS BLOCK A* — **FIRST FLOOR**

12:30 – 13:30

LUNCH BREAK » RESTAURANT RÔTISSERIE

13:30 – 15:00

PARALLEL SESSIONS BLOCK B* — **FIRST FLOOR**

15:00 – 15:30

COFFEE BREAK » GROUND FLOOR

15:30 – 17:00

PARALLEL SESSIONS BLOCK C* — **FIRST FLOOR**

17:15 – 18:45

PLENARY 2: PANEL DISCUSSION – SCIENCE-POLICY LINK / Panelists: *Ursula Schäfer-Preuss, Jakob Rhyner, Fritz Holzwarth, Torkil Jønch Clausen, Geraldo Martha, Dinesh Kumar* — **GROUND FLOOR** (Saal Reger)

19:30 – 22:00

CONFERENCE DINNER

The Conference Dinner will take place at the Restaurant DACAPO on Monday 19th of May, 20:00 h.

Before the dinner, there will be a reception starting at 19:30 h. A bus shuttle will be provided from the Maritim to the restaurant between 19:00 h and 19:30 h.

Tuesday, May 20th

9:00 – 10:45

PLENARY 3: GOVERNING THE NEXUS FOR TRANSFORMATIONS TOWARDS A SUSTAINABLE FUTURE / Speakers: *Joachim von Braun, Dirk Messner, Claudia Pahl-Wostl, Albert Butare, Annukka Lipponen* — **GROUND FLOOR** (Saal Reger)

10:45– 11:00

COFFEE BREAK » GROUND FLOOR

11:00 – 12:30

PARALLEL SESSIONS BLOCK D* — **FIRST FLOOR**

12:30 – 13:30

LUNCH BREAK » RESTAURANT RÔTISSERIE

13:30 – 15:15

PLENARY 4: SCIENTIFIC APPROACHES TO IMPLEMENTING THE NEXUS AT VARIOUS SCALES / Speakers: *Byung-Wook Lee, Andrew Noble, Joseph Alcamo, Johan Kuylenstierna, Zafar Adeel* — **GROUND FLOOR** (Saal Reger)

15:15 – 15:30

COFFEE BREAK » GROUND FLOOR

15:30 – 17:00

PLENARY 5: MINISTERIAL PANEL ON THE W-E-F SECURITY NEXUS AND ECOSYSTEM SUSTAINABILITY IN THE POST 2015 AGENDA FOR SUSTAINABLE DEVELOPMENT organized by BMUB and BMZ — **GROUND FLOOR** (Saal Reger)

17:00

CLOSING CEREMONY (Saal Reger)

PLENARIES

PARALLEL SESSIONS

BREAKS

Overview Parallel Sessions*

PARALLEL SESSIONS BLOCK A		ROOM	CHAIR	PAGE
A01	Special Session: The Water-Energy Nexus in Shared River Basins – How Hydro-Power Shapes Cooperation and Coordination	Salon Hauptmann	Waltina Scheumann (DIE)	25
A02	Special Session: Earth Observations, Monitoring and Modelling for the Sustainable Implementation of the Nexus Approach	Salon Rheinaue	Richard Lawford (GWSP)	28
A03	Special Session: The Need for Horizontal and Vertical Coordination in Governing the W-E-F Nexus	Saal Reger	Claudia Pahl-Wostl (GWSP)	32
A04	Special Session: Agriculture, Biofuels, and Watersheds: Nexus Governance Challenges at Local and Global Scales	Salon Lenné	Jan Börner (ZEF)	35
A05	Special Session: Water Visions Lab Network – Networking Innovations for a Sustainable Water Future	Salon Arndt	Friedrich Barth (GWP)	37
A06	Special Session: Implementing the Nexus in the MENA Region	Salon Haber	Rabi Mohtar (Texas AM Univ.)	38

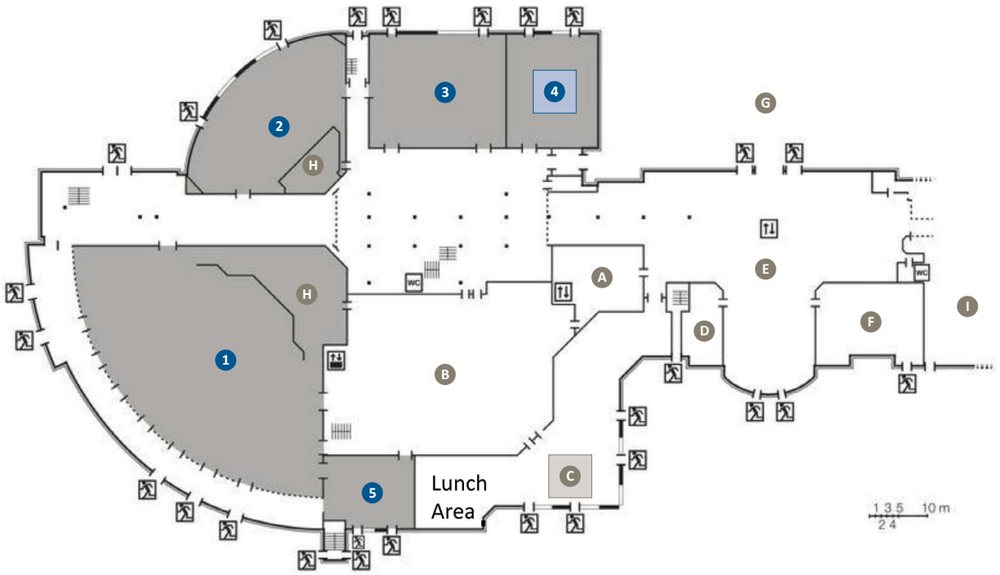
PARALLEL SESSIONS BLOCK B		ROOM	CHAIR	PAGE
B01	Environment and Wellbeing: The Role of Ecosystems for Sustainable Development	Salon Lenné	Francisco Meza (GWSP)	41
B02	Governing the Nexus: Tools and Case Studies	Salon Rheinaue	Joyeeta Gupta (GWSP)	44
B03	Special Session: Sustainability – the Hidden Dimension of the Water-Energy-Food Nexus	Saal Reger	Thomas Chiramba (UNEP)	47
B04	Implementing the Nexus at Various Scales: Transboundary Challenges and Solutions	Salon Haber	Charles Vörösmarty	48
B05	Special Session: The Nexus and Climate Change Adaptation	Salon Arndt	Youngil Song (KEI)	51

PARALLEL SESSIONS BLOCK C		ROOM	CHAIR	PAGE
C01	Special Session: Towards UN-Coordinated Support to the Implementation of the Nexus	Salon Arndt	Thomas Chiramba (UNEP)	55
C02	Special Session: Institutional Capacity Development for Advancing the Nexus Approach	Salon Rheinaue	Jens Liebe (UNW-DPC)	56
C03	Special Session: Ecosystems and their Services in the Nexus	Saal Reger	Claudia Ringler (WLE)	58
C04	Special Session: Nexus Implementation Pathways in River Basins – Political, Economic and Community Narratives for Action	Salon Lenné	Henry Venema (IISD)	61
C05	Tools to Address Synergies, Trade-Offs and Resource Efficiency	Salon Haber	Rabi Mohtar (Texas AM Univ.)	65
C06	Approaches to Resource Management for the Nexus	Salon Hauptmann	Hong Yang (GWSP)	69

PARALLEL SESSIONS BLOCK D		ROOM	CHAIR	PAGE
D01	Implementing the Nexus at Various Scales: Connecting Metropolitan Regions and their Environment	Salon Hauptmann	Luis Veiga da Cunha, (Calouste Gulbenkian Found.)	73
D02	Special Session: Sustainability in the Water-Energy-Food Nexus: An Environmental Resources Perspective	Salon Arndt	Reza Ardakanian (UNU-FLORES)	76
D03	Special Session: Co-optimizing Solutions for Water and Food – Scoping the Nexus Challenges in the Agro-Sector and Finding Scalable Business Solutions	Saal Reger	Joppe Cramwinckel (WBCSD)	80
D04	Governance and Management of the Nexus: Structures and Institutional Capacities	Salon Rheinaue	Christoph Görg (UFZ)	82
D05	Tools for Sustainable Implementation of the Nexus Approach: Instruments and Tools for Integrated Planning	Salon Haber	Holger Hoff (SEI)	85
D06	Implementing the Nexus at Various Scales: Local and Regional Perspectives	Salon Hauptmann	Felino Lansigan (GWSP)	89

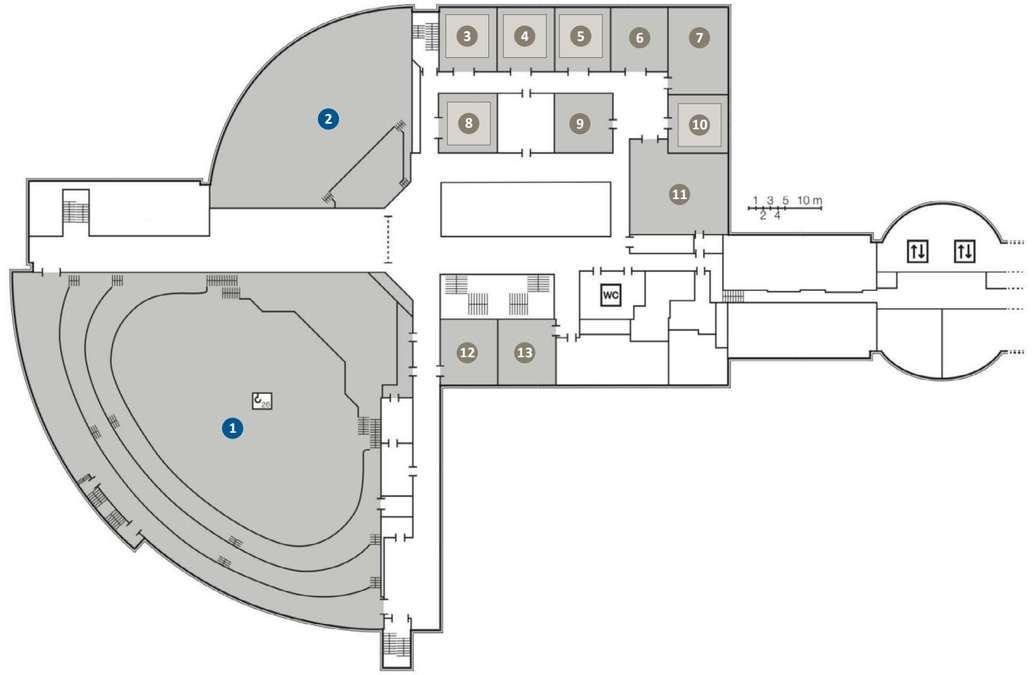
Floor Plan

Ground Floor



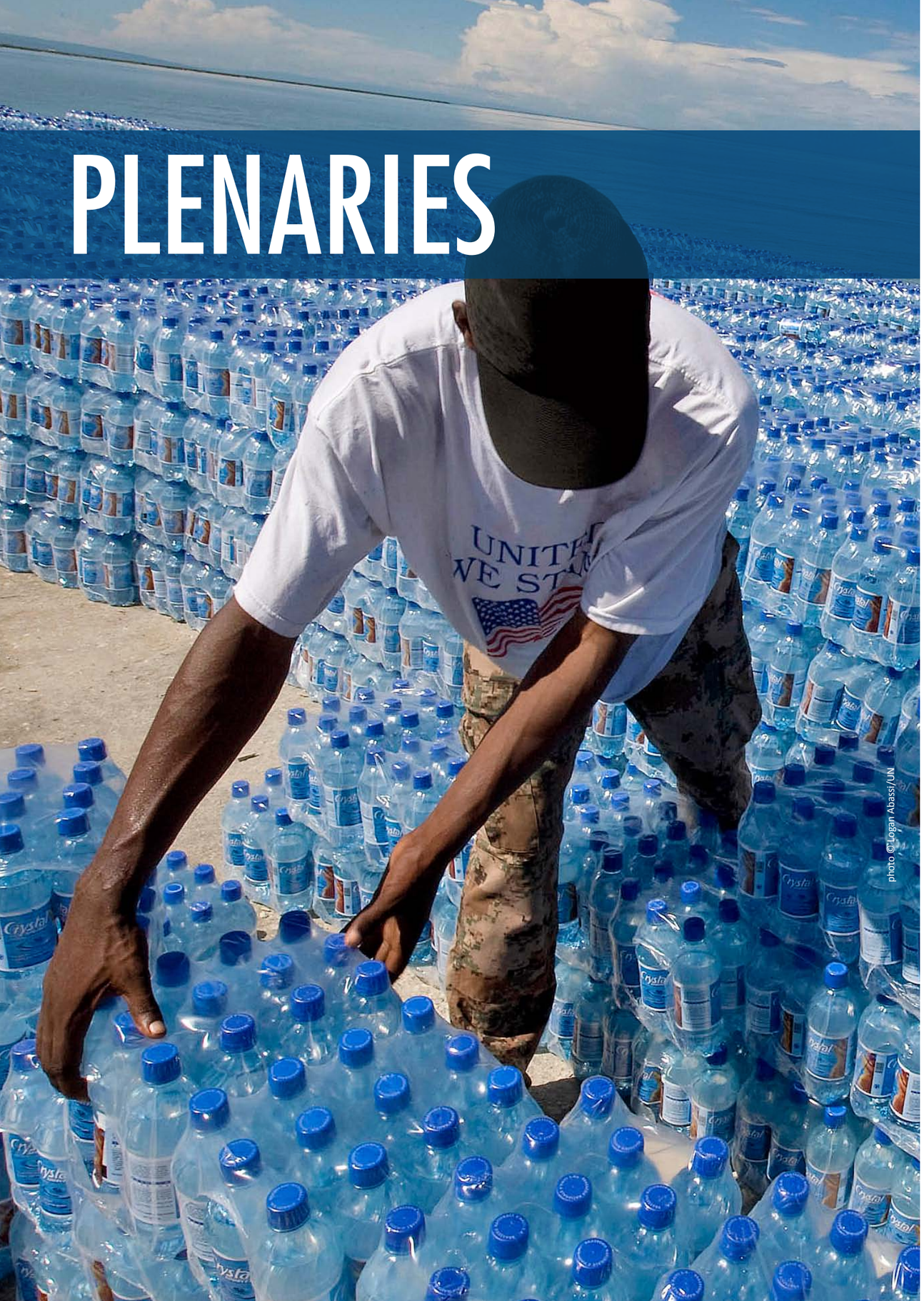
- 1 SAAL/HALL Maritim
- 2 SAAL/HALL Beethoven
- 3 SAAL/HALL Schumann
- 4 SAAL/HALL Reger
- 5 SAAL/HALL Liszt
- A Bistro La Marée
- B Hotel Administration
- C Restaurant Rotisserie
- D Café Brasserie
- E Foyer
- F Pianobar
- G Access to hotel/underground car park
- H Stage
- I Access to hamam, swimming pool, fitness and wellness area

First Floor



- 1 ATTIC HALL Maritim
- 2 ATTIC HALL Beethoven
- 3 Salon Rheinaue
- 4 Salon Lenné
- 5 Salon Haber
- 6 Salon Mann
- 7 Salon Arndt
- 8 Salon Hauptmann
- 9 Salon Planck
- 10 Salon Arndt
- 11 Salon Haydn
- 12 Salon Einstein
- 13 Salon König

PLENARIES



#1 Opening Plenary: Sustainability in the W-E-F Nexus

moderated by Anik Bhaduri (GWSP)

The session will provide an introduction to the need for a nexus approach that reduces tradeoffs and builds synergies across sectors in order to reduce costs and increase benefits for humans and nature. Instead of independent approaches to the management of water, energy, food and the environment, we need a joint global responsibility and cooperation among scientists and policy makers. Since all sectors within the nexus rely on ecosystem services for their functioning, an ecosystem oriented nexus approach is encouraged to mediate tradeoffs and explore synergies towards human well-being and healthy ecosystems.

Speakers:

WILFRIED KRAUS
Federal Ministry of Education and Research (BMBF), Germany: Director of the Division for Sustainability, Climate and Energy

ACHIM STEINER
Executive Director of the United Nations Environment Programme (UNEP) (tbc)

IMME SCHOLZ
Deputy Director of the German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)

CHARLES VÖRÖSMARTY
Chair of the Global Water System Project (GWSP)

#2 Science-Policy Link Panel

moderated by Janos Bogardi (GWSP)

Panelists:

URSULA SCHÄFER-PREUSS
Chair of the Global Water Partnership (GWP)

JAKOB RHYNER
Director of United Nations University Institute for Environment and Human Security (UNU-EHS)

FRITZ HOLZWARTH
Former Deputy Director-General of the Federal Ministry for the Environment, Germany

TORKIL JØNCH CLAUSEN
Chair of the Scientific Programme Committee for the World Water Week in Stockholm and Senior Adviser to the Global Water Partnership (GWP)

GERALDO MARTHA
Embrapa, the Brazilian Agricultural Research Corporation

DINESH KUMAR
Director of the Institute for Resource Analysis and Policy

The panel addresses the sustainability of the Water-Energy-Food nexus as a key research-for-action initiative that needs an international policy consultation process to inform, influence, and catalyze action by key stakeholders—including policymakers, non-governmental organizations, the private sector, educators, and researchers. In particular, the panel will focus on how the science policy link can be strengthened through co-design of research and solutions, though sharing available information, knowledge and action gaps, as well as viable instruments and approaches and the facilitation of networks to ultimately contribute to consensus on priorities for appropriate investment and action towards a sustainable Water-Energy -Food nexus.

#3 Governing the Nexus for Transformations towards a Sustainable Future

moderated by Thomas Chiramba (UNEP)

Speakers:

JOACHIM VON BRAUN
Director of the Center for Development Research (ZEF)

DIRK MESSNER
Director of the German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)

CLAUDIA PAHL-WOSTL
Chair of the Global Water System Project (GWSP)

ALBERT BUTARE
CEO of the Africa Energy Services Group (AESG)

ANNUKKA LIPPONEN
Environmental Affairs Officer of the United Nations Economic Commission for Europe (UNECE)

Despite strong food, water, energy and environment linkages, practitioners and policymakers continue to approach developing programs and policies in the "silos" of their respective ministries or organizations. Mechanisms must be created to raise policymakers' awareness of these issues and promote greater collaboration among ministries as well as communities, civil society, and the private sector in policy design and implementation. Institutional arrangements have to be formed at different levels in order to create an enabling environment for a paradigm shift away from disjointed ministries, programs, and policies. Instead, governance of the nexus needs well-connected government initiatives that take into account the complexity of linkages between water, food and energy to maximize positive results and minimize harmful impacts.

#4 Scientific approaches to implementing the nexus at various scales

moderated by Claudia Ringler (IFPRI)

Speakers:

BYUNG-WOOK LEE
President of the Korea Environment Institute (KEI)

ANDREW NOBLE
Director of the CGIAR Research Program on Water, Land and Ecosystems (WLE)

JOSEPH ALCAMO
Professor at the Center for Environmental Systems Research of the University of Kassel, Germany

JOHAN KUYLENSTIERNA
Executive Director of Stockholm Environment Institute (SEI)

ZAFAR ADEEL
Director of the United Nations University Institute for Water, Environment and Health (UNU-INWEH)

At the community level, small hydropower and water-energy governance mechanisms could help address nexus tradeoffs. At the national level, investments in land, water and energy have to be weighed against each other. At the regional and global levels, trade, climate and energy policy are important policy arenas that need to be considered for nexus thinking. This plenary will discuss the different challenges and solutions in implementing nexus approaches at different scales and how these scales are linked with one another through synergies and trade-offs.

#5 Ministerial Panel on the Water, Energy and Food Security Nexus and Ecosystem Sustainability in the Post 2015 Agenda for Sustainable Development

Institutions:

BMUB
German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

BMZ
Federal Ministry for Economic Cooperation and Development

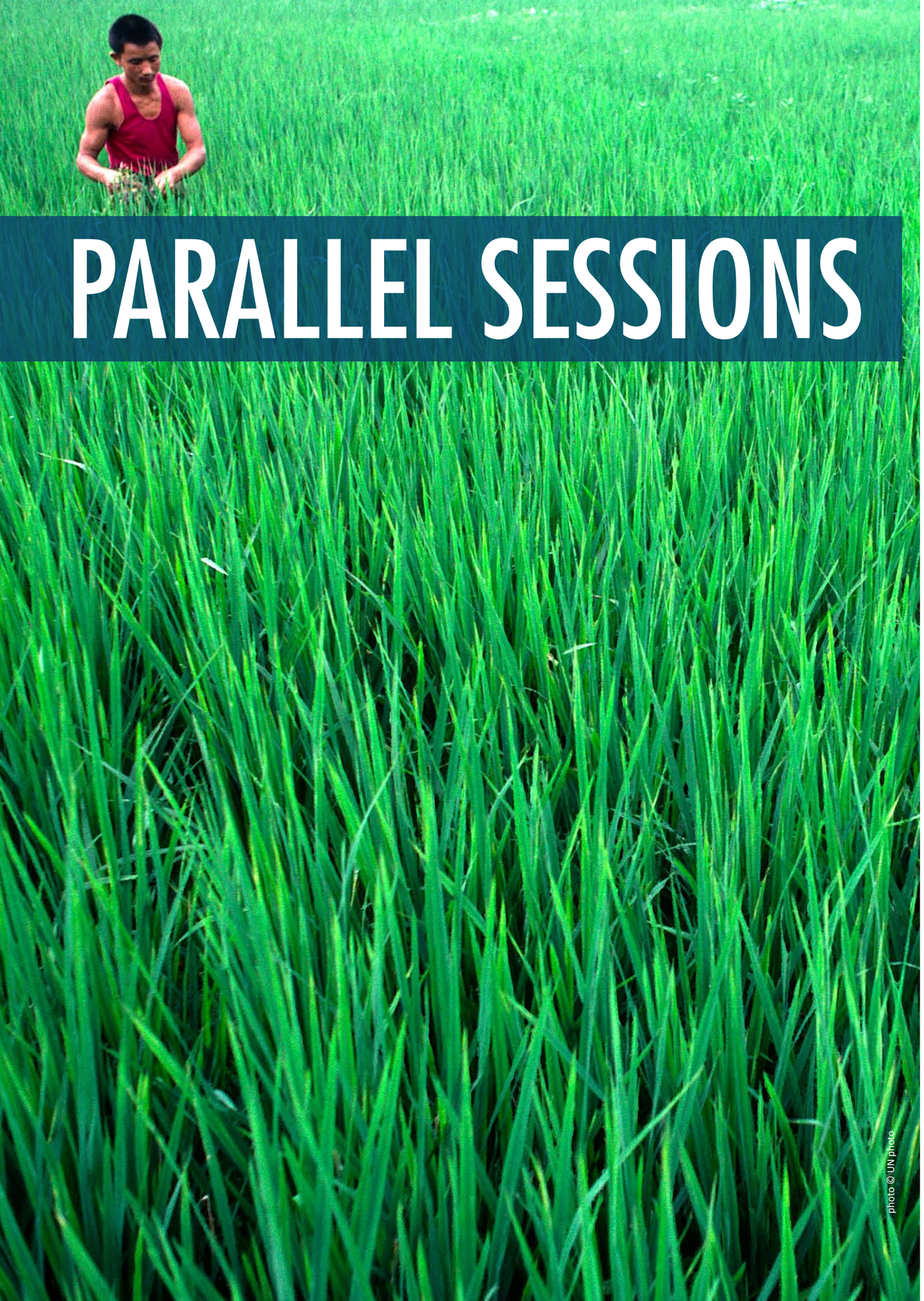
Water, energy and food security are closely interrelated and among the world's most pre-eminent challenges. Since the Bonn2011 Conference 'The Water, Energy and Food Security Nexus – Solutions for the Green Economy' the recognition of the need to address these challenges in an integrated cross-sectorial way has gained more and more momentum. The post 2015 Agenda for sustainable development will have to respond to these challenges to eradicate poverty, build resilient societies and foster sustainable development. High-level political representatives from major regions involved with the three sectors will discuss together with representatives from the German government and UNEP on:

- How interlinkages of water, energy and food can be best captured in the post 2015 Agenda for sustainable development?
- Which information, approaches and tools are necessary to support nexus action in the follow up-process on the post 2015 Agenda for sustainable development?
- Which governance structures at national, trans-boundary and international level are conducive to make the nexus reality?

An open debate with the audience will enrich the discussion with perspectives from different stakeholders.

Closing Ceremony moderated by

Anik Bhaduri (GWSP) and Thomas Chiramba (UNEP)



A01 Special Session: The Water-Energy Nexus in Shared River Basins - How Hydro-Power Shapes Cooperation and Coordination

SESSION CHAIR(S)
Waltina Scheumann

ROOM
Salon Hauptmann

DATE
Monday, May 19
11:00 – 12:30

INSTITUTION
German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)

Ines Dombrowsky *(German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE) , Bonn)*
» Introduction to the session

1 Oliver Hensengerth *(Northumbria University, Newcastle, UK)*
» The power of norms in hydropower.
Building the Xayaburi Dam on the Lower Mekong

2 Aysegül Kibaroglu *(Department of International Relations, Okan University, Istanbul, Turkey)*
» Turkish Foreign Policy and Water: Reflections on the Euphrates-Tigris Case

3 Waltina Scheumann (German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE), Bonn)
» Hydropower on the River Coruh on both sides of the border: Turkey and Georgia

4 Susanne Schmeier *(Gesellschaft für Internationale Zusammenarbeit, Frankfurt, Germany)*
» Empowered to govern hydropower? The role of River Basin Organizations in ensuring sustainable hydropower development at the basin level

SUMMARY

On shared river basins, hydropower projects pose challenges for both cooperation between riparian states and coordination between sectors, including the water, energy and environment sectors. Both cooperation between states and coordination between sectors are not automatically forthcoming because of conflicting and often inconsistent objectives of nationally pursued (sector) policies.
Due to the absence of a supra-national authority in shared river basins, it is the self-motivation of riparian states as well as of sectors and actors involved which are the driving forces for both cooperation and coordination – or their absence. However, usually neither the riparian states nor the sectors are equal partners but differ in power and resources, hence power also plays a role in shaping cooperation and coordination. The latter refers to the relative power one riparian state and one sector may enjoy over the other(s) (hydropower versus water/ environment and vice versa etc.).
Hence, in order to understand processes of cooperation and coordination, and their respective outcomes, both interests and power constellations between the respective actors needs to be looked at. The participants will therefore discuss how riparian cooperation and cross-sectoral coordination plays out given that interests and power plays a role in both.
The Special Session focuses on shared river basins with hydropower dams, among others the Mekong and the Euphrates-Tigris rivers. It particularly discusses: How do interests and the relative power of riparians impact cooperation related to dam/hydro projects in shared basins? How do (sector) interests and relative power impact on cooperation and sector coordination, in particular in relation to 'sustainability' issues? What role do international river basin organizations play in balancing interests and asymmetric powers of riparian states and sectors? Whom do they represent, and do internal power asymmetries play a role?

A01 Abstracts

1 Oliver Hensengerth

The rise of the private sector in Mekong countries has changed the dynamics of dam financing: no longer are Northern donors dominant, but private and large state-owned firms from Thailand, China and Vietnam. Domestic elites can now circumvent Northern donors by working with regional firms. The normative beliefs and interests of domestic elites determine which sectors are given preference (e.g. energy or environment), and whether actors in different sectors compete or cooperate.
The paper views power as having ideational and structural elements. Ideational elements determine interests, while structures determine the position of actors both in terms of sectors and riparian states. Ideationally driven actors can create structures to push their ideas in the policy process. It is in this development where both types of power – hydro-hegemonic and sectoral – are linked.
While ideas determine interests, these interests determine multi-lateral cooperation. For Xayaburi, the Lao government has a dominant interest in hydropower development. It has led a discourse on economic development in which development and environmental protection are mutually exclusive. To protect its interest, Laos has eschewed regional negotiations in the MRC and opted for bilateral negotiation with downstream countries. While doing so, it has struck alliances with the Thai private sector to plan, fund and build Xayaburi. To receive additional legitimacy, it has contracted international engineering firms. Domestically, the authoritarian system shuts out civil society influence and prevents the rise of a well-funded environmental bureaucracy.
At the same time, the MRC with its IWRM mandate commissioned an environment consulting firm to conduct a SEA of the proposed Mekong dams. Downstream Cambodia and Vietnam as well as regional and international NGOs have seized on this to delegitimize the Lao discourse.
We thus have sets of actors engaged in contending normative discourses, creating a structure that is not conducive to cooperation – between the energy and environmental sectors, and between the governments of riparian states. The latter conflict consists in a dispute between upstream Laos and Thailand; and downstream Cambodia and Vietnam.
The key power resource of the Lao government is its ability to insulate decision-making. Ideationally likeminded actors create alliances that produce competitive structures between sectors and countries. Depending on the alliances and their power sources, hydro-hegemony works upstream or downstream. Laos's alliance with Thailand makes it a hydro-hegemonic state in Mekong dam development. To evaluate the inter-linkage of both types of power, we therefore face two tasks: an examination of elite interests, and an analysis of how these elites attempt to push their interest in regional water politics.
A focus on norms, interests and power is therefore useful.

2 Aysegül Kibaroglu

Turkey is a pivotal country in the Eurasian landscape with her steadily growing economy, particularly in the times of the world-wide economic crisis, which hit many developed countries badly and drastically slowed down their economic growth. In line with her economic growth ventures, Turkey is determined to develop her considerable water resources potential to the full extent. To illustrate, the political rhetoric in Turkey keeps emphasizing that only a third of the country's water resources have been developed, and there is still a huge potential for water resources development. So at national level, water resources development for energy and food production has become the overarching aim. Particularly this developmentalist venture of water policy in Turkey brought additional difficulties in her relations with her neighbors simply because of the fact that a significant portion of her water resources are crossing political boundaries. So, claims and counter-claims between Turkey and her neighbors have long constituted the regional transboundary water governance trends.
In this context, the paper will basically aim at understanding, explaining and analyzing the foreign policy and state practice of Turkey, major actor in global and regional water politics, having influenced the regional water relations with her vital interests and by leaving large footprints in her neighborhood. Her state practices include a rich history of treaty practices as well as encompassing political statements and actions which culminated in regional water governance trends displaying consensus, but in most cases disagreements.
Geographically connected to southwest Asia (Middle East), Caucasus and Europe, Turkey's international water policy perspectives are shaped by those geographical determinants. Interestingly, Turkey has reflected her experience in one region (Europe) into the practices with the other, namely in the Middle East. The paper will analyze how Turkey's harmonization with the European Union have had impacts on the transboundary water policy discourses and practices in Turkey, and how these changes have been reflected on her relations with the Middle Eastern neighbors. In this context, transboundary water politics in the Euphrates-Tigris region will be particularly scrutinized with its entrenched complexities. Historical account of transboundary water relations will be enriched with the analysis of the current state of affairs in the region. In this context, the Syrian civil war and its repercussions on water issues and the growing "resource nationalism" in the region will be part of the discussions in the paper.

3 Waltina Scheumann

The Coruh / Chorokhi river system has a largely undeveloped hydropower potential on both sides of the border – in Turkey and Georgia – where a large number of hydropower projects are planned and under construction with private capital. The paper explores the international dimension(s) of the unilaterally pursued hydropower projects on a transboundary river system which is typically characterized by upstream-downstream conflicts. It founds that hydropower has been a motor for regional cooperation, although not all issues are settled. It is assumed that those related to the synchronization of hydropower plant operations will be dealt with in the context of electricity trade consultations for which a joint committee serves as a platform. With changing issues on the transboundary river system, the actors to settle them are now the Energy Ministers and private utilities that are motivated to do so the regional electricity market relies on them. The hydropower / energy sector has gained 'power' and hence justify the poor integration of environmental and social (expropriation) concerns in planning and implementing renewable projects on the ground that they protect a global public good (climate), contribute to electricity security and decrease dependency on energy imports.

4 Susanne Schmeier

Water resources management and hydropower development are often driven by very different economic, social and political considerations. River Basin Organizations (RBOs) in charge of integrated water resources management at the transboundary level are therefore often caught between these conflicting interests and the strategies through which different riparians push for their respective interests. The paper addresses the question whether and under which conditions RBOs are able to bridge the water-energy divide and ensure the integrated management of transboundary river basins under hydropower development – especially if interests of riparian states with regards to developing hydropower or protecting the river's resources for other uses vary. It aims at identifying factors that influence RBO effectiveness in dealing with hydropower-related challenges in transboundary basins where interests, strategies and the distribution of power among riparian states diverge. The paper looks at the way RBOs address hydropower-related problems. After identifying potential factors that define an RBO's capacity to address diverging interests of riparian states with regards to hydropower development, the presentation maps the distribution of these factors across RBOs. This relies on findings generated from the RBO Database included in the Transboundary Freshwater Dispute Database (TFDD), which provides data on the institutional design of all international RBOs. The analysis focuses on some key features of RBOs that are designed to ensure effective river basin governance in spite of diverging interests among their members, namely their issue coverage and thus the question whether they are mandated to address water and energy in an integrated manner, their decision-making mechanisms and thus the extent to which they can facilitate decisions over hydropower projects in an effective manner, their dispute resolution mechanisms and hence their capacity to bridge conflicting interests not only among sectors but more importantly also among riparian states, ensuring the sustainable development of the entire basin, as well as their means for including non-state actors, including the private sector, in order to ensure that sustainability standards are actually being implemented, even under situations of weak governance.
It is found that many RBOs, in spite of being asked to manage challenging situations in transboundary river basins, lack the appropriate institutional design for doing so. Consequently, many RBOs are left in the water-energy trap. Solving hydropower-related conflicts therefore requires strengthening RBOs. While this is a challenging task – especially in times of conflict in a transboundary basins – experiences from around the world provide important lessons learned on how to bridge the water and the energy world by developing both technical and political responses to transboundary hydropower challenges.

A02 Special Session: Earth Observations, Monitoring and Modelling for the Sustainable Implementation of the Nexus Approach

SESSION CHAIR(S)
Richard Lawford

ROOM
Salon Rheinaue

DATE
Monday, May 19
11:00 – 12:30

INSTITUTION
Global Water System Project (GWSP)

1 Aiko Endo *(Research Institute for Humanity and Nature, Kyoto, Japan)*
» An integrated map to coordinate coastal policies and water resource policies in Japan: visualizing a water, energy and food nexus

2 Peter Rutschmann *(Technische Universität München, München, Germany)*
» The NeXus Water – Food – Energy project at TUM and partner universities

3 Douglas Cripe *(GEO Secretariat, Geneva, Switzerland)*
» Using Earth Observations for Integrated Water Resources Management

4 Richard Lawford *(Morgan State University, Baltimore, USA)*
» Using Earth observations to address the basin-scale information needs of the Water- Energy-Food Security Nexus

SUMMARY

There are a number of motivations for addressing the Water-Energy-Food (W-E-F) security nexus issue on a priority basis. These range from the opportunity for many poorer countries to meet their internal food, energy and water requirements through better access to relevant data and information, the need for greater efficiency in the use of inputs to produce agricultural products, the need to maximize the economic and ecosystem goods and services benefit of water that nearly all communities could have available to them, and the need to maintain sustainable water availability in areas where agriculture and energy production, processing and use is very intense. All of these issues are affected by national trade policies, by global economic markets, and global climate. Given the complexity of W-E-F issues, it is vital that the information being used for making these decisions is accurate, complete and widely distributed to ensure that the decision processes are as broadly supported, transparent and robust as possible. The Earth observation community can play a major role in ensuring that the data services developed for the W-E-F security nexus will support the needs of decision makers and promote sustainability in this nexus. In particular, this session will focus on the data and information needs of the W-E-F security nexus and the ability of the Earth Observation community to meet these needs. Success stories in which observations and data products are successfully supporting W-E-F decisions will be presented. Decision- makers will provide perspectives on their needs in terms of the most critical variables, the frequency and the spatial and temporal scales of the information needed, and the degree to which these needs are currently being met. Representatives of the Earth observations community, including space agency representatives, will describe the data and services that can be currently provided or will be provided in the near future. Information gaps will be identified and discussions will focus on identifying activities, projects and other actions that could be undertaken to strengthen information services for the W-E-F security nexus.

A02 Abstracts

ABSTRACTS

1 Aiko Endo

In Japan, multisectoral coordinating mechanisms, and a comprehensive and integrated approach for ocean governance was needed. In 2007, the Basic Act on Ocean Policy was enacted consisting of 6 basic principles and 12 basic policy measures. The development of an Integrated Coastal Management, or ICM is one of the basic policy measures. This Act was the first to formally recognize the need for implementation of ICM. In the subsequent year, the Basic Plan on Ocean Policy was established. It clarified the essential of integrated management of land and coastal areas. Under the Basic Plan on Ocean Policy, each ministry engages in ICM. And the Secretariat of the Headquarters for Ocean Policy of the Cabinet Secretariat was established to implement an integrated marine policy as a multi-sector coordinating body.
The Japanese coastline is about 35,000 km long and is practically divided into 7 categories: former Ministry of Construction coast, commercial port, fishing port, coast for agricultural land, co-management coast, general public coast and others. That is, each area is managed by different bodies who manage different targets. Each national government entrusts the management activities to local governments, however, there are no administrative boundaries within the territorial waters of Japan and there is also no national legislation in Japan that clearly delineates the offshore boundary between the coastal local government and national government. Along the coastal areas, which is wider than coastline, right-based fishing activities are conducted and licensed fishing activities are operating in the offshore which are managed by the Japan Coast Guard under the National Property Act.
Regarding water resource management, the Basic Act on Water Cycle will be enacted sooner or later. The act says the water is natural heritage and establishment of an integrated water management system is needed. The national government is going to set up the Secretariat of Headquarters for an integrated water management under the Act. Currently the 7 Ministries and Agencies are involved in the Japanese water management. Moreover, spring water management, which is not currently covered by the national legislation, will become the management target under the Act. Since the study for the nexus between spring water nutrition and fisheries products in coastal waters is being developed in Japan, the need for managing spring water along the coastal areas where there is no administrative boundaries, will be recognized more and more. The purpose of this study is firstly to review coastal policies and water resource policies and secondly to consider how to developing an integrated map to integrate coastal policies with water resource policies in Japan.

2 Kordula Schwarzwälder, Peter Rutschmann

In times of climate change, population growth and globalisation can both rapidly and unpredictably change the world. It is thus a challenge of high importance to handle the interactions between different key topics like water, food and energy. To deal with the emerging problems such as social and political conflicts at worst, it is necessary to know more about the linkage between the different fields influencing and driving these problems. To tackle food problems we need to also understand energy production influencing the food sector e.g. via biomass, we need to consider the water used for irrigation, which can lead to salinization. Moreover, in one fell swoop, flooding events can destroy an entire year´s crops. This is just a short and very simple outline of all these highly complicated linkages between water, food and energy. But so far not much research has been done in building a nexus of these topics, a nexus in water, food and energy, which needs an overall and integrated view. Also no specific educational courses at universities exist until now.
It is a huge task and the people who are responsible for making decisions in that area of conflict need a good basic knowledge and education to be able to solve problems in a more integrative and effective manner.
Therefore TUM (Technische Universität

A02 Abstracts

München) started an initiative, “NeXus Water – Food – Energy”, to develop a network of highly qualified and interested scientists and institutions. It is backed by a DAAD-funded strategic partnership in order to bundle the necessary capacity for addressing some of the main scientific questions of the nexus and to create a nucleus in the fields of water, food and energy. The final result will be a NeXus master course among the strategic partners. These partners are universities in Europe (DTU, EPFL, NTUA) and USA (Colorado School of Mines) as well as universities in Egypt, Ethiopia and Tansania. The NeXus is also linked to NIMA-NEX, which is a project of the TUM International School of Science and Engineering related to drought modelling and monitoring in the Nile river basin and at Omo Gibe river.
The actions not only involve researchers, but also university administrations to harmonize administrative tasks for the collaboration and the exchange programs. Innovative ideas, novel educational programs for students and translation of research results and data to the population (social inclusion) in order to gradually change human attitudes are required to design and implement more sustainable approaches where production of food, water management (from water supply to wastewater recycling as well as management of surface and groundwater resources) and renewable energies are considered in an integrated manner.

Acknowledgments
This project is supported by German Academic Exchange Service (DAAD)

3 Douglas Cripe, Richard Lawford, Toshio Koike

Earth observations can help reduce the loss of life and property from natural and human induced disasters through increasing our understanding of complex environmental systems. It is crucially important to recognize and co-manage the fundamental linkages across: water-dependent domains; land use, including deforestation; ecosystem services; and food-, energy- and health-securities. Sharing coordinated, comprehensive and sustained observations and information for sound management and decision-making in these domains is a first step; however, to take full advantage of these opportunities, we need to develop an effective collaboration mechanism for working together across different disciplines, sectors and agencies, and thereby gain a holistic view of the continuity between environmentally sustainable development, climate change adaptation and enhanced resilience.
In this context, the Global Earth Observation System of Systems (GEOSS) is being built through the coordination of efforts within the international Group on Earth Observations (GEO), a voluntary partnership established in February 2005, comprised of 89 Member States, the European Commission and 77 Participating Organizations. The 10-Year Implementation Plan defines a vision statement for GEOSS, its purpose and scope, expected benefits for nine “Societal Benefit Areas” (SBAs) (disasters, health, energy, climate, water, weather, ecosystems, agriculture and biodiversity), technical and capacity building priorities, and the GEO governance structure.
The full value of GEOSS lies in its ability to integrate Earth observation data and information across disciplines. As an example of this capacity in the water sector, GEO has established the GEOSS Asian Water Cycle Initiative (AWCI) and African Water Cycle Coordination Initiative (AfWCCI). Through regional, inter-disciplinary, multi-sectoral integration and interagency coordination in Asia and Africa, GEOSS is now leading to effective actions and public awareness in support of water security and sustainable development.
At the GEO Geneva Ministerial Summit in January of this year, GEO received full Ministerial support for a renewed mandate through 2025. Included in the Geneva Ministerial Declaration is a call for GEO to “take…into account commitments to the United Nations Sustainable Development themes” in the development of the new 10-year implementation plan for GEOSS.
In parallel, the value of GEOSS is explicitly acknowledged in Article 274 of The Future We Want (Outcome document, United Nations Rio+20 Conference on Sustainable Development), which recognizes the importance of space-technology-based data, in situ monitoring and reliable geospatial information for sustainable development policymaking. GEOSS is thus well positioned to help support and address several of the recommendations contained in the Bonn Declaration on Global Water Security, and contribute to future efforts towards sustainability in the water-energy-food nexus.

A02 Abstracts

4 Richard Lawford

The Earth Observation community is developing new integrated capabilities around the theme of the Water-Energy-Food (W-E-F) security nexus. This talk outlines why this nexus has become a focal point for the Earth Observation community and discusses the types of information systems that are being envisioned to support decision-making related to W-E-F security nexus issues. The types of information required range from assessments of the distribution of water availability and quality over different time and space scales, land cover characteristics and changes, energy inputs and efficiency, and agricultural productivity. The paper also discusses the more general role of information in supporting the analysis and planning of water management, energy services and agriculture on national and basin scales. The results of investigations that provide different perspectives on the role of basin-scale water management in addressing the W-E-F security nexus issues will also be presented. These studies identify the relative importance of factors such as climate and level of economic development. The presentation concludes with a proposed approach for further examining the regional differences in needs for information to support W-E-F decision-making and with some initial concepts of operational information systems needed to support W-E-F nexus decision making.


photo © UN photo

A03 Special Session: The Need for Horizontal and Vertical Coordination in Governing the W-E-F Nexus

SESSION CHAIR(S)
Claudia Pahl-Wostl

ROOM
Saal Reger

DATE
Monday, May 19
11:00 – 12:30

INSTITUTION
Global Water System Project (GWSP)

SPEAKERS

1 Marianne Beisheim *(Stiftung Wissenschaft und Politik, Berlin, Germany)*
» Reviewing for results: Incentives for cross-sectoral "Nexus" orientation at different levels

2 Isabel Bortagaray *(SARAS Institute, Maldonado, Uruguay)*
» Navigating multiple transitions: The institutional arrangements and governance system around the W-E-F nexus in Uruguay

3 Christina Aue (*Oldenburgisch-Ostfriesischer Wasserverband, Brake, Germany)*
» Problems related to the W-E-F Nexus from the perspective of a Water Supplier

4 Joyeeta Gupta *(Amsterdam University, The Netherlands)*
» The Nexus Approach and Legal Pluralism: Horizontal vertical coordination challenges

SUMMARY

Coordination of policy fields is a major challenge for governing the nexus. How much can and should be coordinated during policy development and during policy implementation. Which instruments are available, what is in place?
The presentations reflect different perspectives from science, practice, and policy.
Questions to be addressed during the discussion include:

- How much can and should be coordinated during policy development and during policy implementation?
- Which instruments are available, what is in place? Transferability of insights
- What are major knowledge gaps and steps towards improvements?

A03 Abstracts

1 Marianne Beisheim

If the challenges in the W-E-F nexus are to be dealt with properly, then cross-sector cooperation and coherence will have to improve. Incentives at different levels are needed to spur action. At the UN level, the future review process at the new High-level Political Forum on Sustainable Development (HLPF) should feature such incentives.
When it comes to mobilising global political will, the UN's post-2015 agenda and the post-Rio+20 process of formulating SDGs for the water, energy and food sectors will play an important role. These goals must take account of the linkages within the W-E-F nexus. The 2013 Stockholm Statement calls for a doubling of global water productivity by 2030. The agricultural and the energy sector must both become more efficient in their use of water. Targets on access to energy or the share of renewable energy will require supplementary provi-sions dealing with water and land use. The future HLPF review process (starting in 2016) must ensure that the international community can incentivise and follow up the implementation of these goals. If the review exposes the nexus risks, if the need and the options for action and support become more visible through that review, this could incentivise political decision makers to scale up their efforts.
Next to these stimuli for UN member states, it is also important to incentivise constructive ideas and voluntary initiatives by non-governmental pioneers on how to implement the nexus approach. The 2002 UN Summit on Sustainable Development called for multi-stakeholder partnerships to help implement the 1992 Rio commitments and later also the MDGs. We now have a number of partnerships for sustainable development that focus on water, energy, or food issues. Various partnerships have been testing and evaluating promising concepts, tools, and pilot projects. The Global Water Partnership (GWP), for example, supports the implementation of integrated water resources management through a tool box and regional or country partnerships.
The Alliance for Water Stewardship (AWS) develops an international standard on the socially equitable, environmentally sustainable and economically beneficial use of water resources. Water and Sanitation for the Urban Poor (WSUP) has developed and successfully implemented locally adapted pilot projects. The IUCN/IWA Nexus Dialogue on Water Infrastructure Solutions aims to identify innovative approaches to the nexus-oriented use of infrastructure, technology and finance. In order to evaluate what initiatives merit public support for scaling up, partnership initiatives should participate in the future HLPF review. The review should incentivise and reward frontrunners that take nexus linkages into account. It should incentivise (1) existing partnerships to consider the nexus linkages in their transnational, national, or local-level work and also (2) new genuine Nexus Partnerships.

2 Isabel Bortagaray, Mariana Meerhoff, Nestor Mazzeo, Manfred Steffen, Hugo Inda, Guillermo Goyenola, Juan Clemente, Franco Teixeira de Mello, Carlos Iglesias, Juan Pablo Pacheco, José Sciandro

This paper analyzes the institutional environment, including the rules of the game, the organizations and the policies, and the governance of the water-food-energy nexus in Uruguay since the year 2000. Based on the adapting institutions perspective (governance, complexity and social-ecological resilience), it studies this nexus and the extent to which the policy and governance system are contributing to a virtuous circle and cumulative learning in Uruguay. More in particularly it analyzes the policy instruments in place, the different policy levels (sectoral, national, regional, inter-policy domain, etc.), the policy phases and the structure and functioning of the socio-technical management network around the W-E-F nexus and their interactions.
Some of the difficulties found around the W-E-F nexus in the country have to do with:

» A policy community trained in the paradigm of control-command
» A strong fragmentation and lack of prevention due to sectoral approaches to problems and solutions
» Unfit of the institutional arrangements around water management (problem of scale, fragmented and isolated policy administration, incoherent policies, among others) and the dynamics of the aquatic ecosystems
» A sound legislation with important

A03 Abstracts

changes in the last few decades that promote the creation of bridging institutions (like the basin committees) and public participation, but that actually face lack of control and monitoring capacity.

» Asymmetric and missing information, difficult for public participation and democracy.

3 Christina Aue

The implications of coordination failure are illustrated from the perspective of a Water Supplier in NorthWest Germany. High livestock densities and excessive manure production have led to severe nitrate pollution of freshwater bodies and problems for the supply of drinking water. Attempts to regulate livestock densities and nutrient flows (e.g. upper limit of livestock per land unit or liquid manure markets) have not yet led to satisfactory improvement. The situation is aggravated by a boom in growing energy crops for renewable energy production. National subsidies supporting electricity production from renewables promoted a steep increase in production. The implications are increased groundwater pollution and a skyrocketing of prices for agricultural land. They arise from a lack of coordination of the water-energy-food nexus. Such developments need to be corrected by adjustement of the fertilizer decree.

4 Joyeeta Gupta

There have been many efforts at promoting coordination at national through to global level. These include efforts at promoting coordination, coherence, integration, mainstreaming and now the nexus approach. Each has its own strengths and weaknesses. While the nexus approach may be able to deal with the challenge of 'turf battles' between different sectors, a key problem is that most individual regimes also face the challenge of legal pluralism – in other words different rules that are applied to the same jurisdiction. Any effort at effective nexus policy has to also effectively understand how to deal with the vertical and complex horizontal legal pluralism challenges that take place at multiple levels of governance. This is illustrated by explaining in depth the horizontal and vertical legal pluralism challenges in the water field - and how this will impact on the nexus relationship. The paper will also try and explain which instruments may help to deal with these multiple challenges. ■

photo: ©UN Photo/Martine Perret

A04 Special Session: Agriculture, Biofuels and Watersheds - Nexus Governance Challenges at Local and Global Scales

SESSION CHAIR(S)
Jan Börner

ROOM
Salon Lenné

DATE
Monday, May 19
11:00 – 12:30

INSTITUTION
Center for Development Research (ZEF)

1 Alisher Mirzabaev *(Center for Development Research, ZEF, Bonn, Germany)*
» Bioenergy in the Nexus: Challenges and Opportunities for Food Security and Poverty Reduction

2 Grace Villamor *(Center for Develoment Research, ZEF, Bonn, Germany)*
» Local actors and gender perspectives in dealing with water, food and energy trade-offs: a case from Jambi, Indonesia

3 Marc Müller *(Center for Development Research, ZEF, Bonn, Germany)*
» Impact of Increasing World-Market Prices for Oilseeds on West African Agriculture

4 Vanesa Rodríguez Osuna *(Center for Development Research ZEF, Bonn, Germany)*
» Managing Water, Environment, Food trade-offs in the Brazilian Atlantic Forest: A case study

ABSTRACTS

1 Alisher Mirzabaev, Dawit Guta

Bioenergy is a vital component of Water-Energy-Food Security (W-E-F) nexus and essential for green growth and poverty reduction. Bioenergy development has substantial impacts on global crop prices, labor and land markets, and on food security. Instead of simple trade-offs between food and fuel, a broader conceptual perspective is required for assessing bioenergy issues, taking into account the three main sustainability domains upon which bioenergy impacts, namely the social, economic and environmental domains. In the rapidly evolving global context, with more tightly interlinked relationship between energy and food markets, the fundamental challenge is to develop and modernize bioenergy production and consumption without undermining the long-term productivity of agriculture and the provision of ecosystems services, and also through providing opportunities for achieving triple-win outcomes in terms of economic development, energy security and food security. This presentation seeks to review the drivers and impacts of bioenergy production and utilization along these three dimensions of sustainability, following an inter-disciplinary W-E-F nexus approach, with a special emphasis on the livelihoods of the poor. Using insights from institutional economics, it suggests national and international governance and institutional tools and mechanisms conducive for catalyzing innovations in the bioenergy production, use and trade.

2 Grace Villamor

Contested rules between the state and local communities over use and protection of forest and its resources affect environmental services and livelihood in the forest margins of Indonesia. By providing the different perspectives and gender lenses of the local actors regarding different land uses, we will address the possible implications of the water-food-energy nexus

A04 Abstracts

at the local context. A case study in Jambi province, where oil palm has rapidly transformed many areas intended for food production and water regulation is provided. We assessed the potential trade-offs using model and game simulation approaches and explored how local based community management (i.e., hutan desa) can resolve conflicting perspectives in achieving the water-food-energy nexus.

3 Marc Müller

Harvested areas for oilplants in West African countries have grown substantially over the last decade. While palmoil remains the dominant oilplant in the forest regions, soybean production has recently gained momentum in the Savannah regions. The main reasons are improved varieties and marketing institutions, but also rising prices for oilseeds on global markets. Demand for biofuel is an important driver for oilseed prices, which in turn depends on the developments of energy prices. In this study, we use a set of single-country General Equlibirum Models with a fairly disaggregated agricultural sector to analyse alternative scenarios regarding teh future development of oilseed production in West African countries. An important question ist o whihc extent cereal production for domestic human use would decline and if substantial increases of agricultural areas could be expected.

4 Vanesa Rodríguez Osuna, Jan Börner, Hartmut Gaese, Udo Nehren, Rachel Bardy Prado, Jürgen Heinrich

Land use intensification, urbanisation processes, and the construction of the largest Brazilian petrochemical complex in Rio de Janeiro are driving ecosystem services degradation in the Guapi-Macacu watershed. This watershed supplies 2.5 million urban water users and sustains farming systems, relevant for national and local food supply-related governmental programmes. Development pressures will probably increase further the demand for watershed services and threaten local food production by rising labour costs in the agricultural sector. Paying farmers to restore watershed services has been proposed to secure long-term water supply. This study quantifies the costs of changing current land use practices to enhance watershed services and compares these to avoided water treatment costs considering tradeoffs with food provision. We use farm-household data to estimate the opportunity costs of land use changes that are known to improve water quality. Opportunity cost estimates are extrapolated to the watershed scale based on land use patterns and vulnerability analysis to identify priority zones for watershed management interventions. Potential demand is analysed based on water quality and treatment cost data from the main local water treatment plant. Changes to intensive agricultural land uses that improve watershed service provision are generally associated with high opportunity costs. Such changes in land uses affect ultimately local food supply. Low-cost watershed service conservation options exist primarily in the cattle and dairy sector, where effects on the local food market are considered to be very low. Land cover changes at the scale needed to improve water quality will, however, likely exceed the cost of additional investments in water treatment. Willingness to pay for watershed services alone coming from the main local water user is thus unlikely to induce additional watershed service provision. Incentive-based watershed management measures conditioned on specific adjustments to existing production systems could still play a complementary role in improving watershed services without compromising local food supply.

A05 Special Session: Water Visions Lab Network: Networking Innovations for a Sustainable Water Future

SESSION CHAIR(S)
Friedrich Barth,
German Water
Partnership (GWP)

ROOM
Salon Arndt

DATE
Monday, May 19
11:00 – 13:30

INSTITUTION
Global Water
System Project
(GWSP)

1 Stefan Uhlenbrook *(UNESCO-IHE, Delft, Netherlands)*
» The need for innovations in water related fields

2 Franz Gatzweiler *(Center for Development Research, University of Bonn, Germany)*
» The scope of implementation research in understanding the process of adopting innovations

3 Anik Bhaduri *(GWSP, Bonn, Germany)*
» The Concept of the Water Visions Lab Network

4 Elmar Schüller *(Innovation Living Institute, Essen, Germany)*
» The Vision of a Water Exploratorium

5 Kamini Ernst *(Federation of Indian Chamber of Commerce)*
» Current approaches of the Indian industry in the face of present and future water challenges

6 Venkatarama Sharma *(Indian Embassy, Berlin, Germany)*
» Indo-German collaborations to enhance the implementation of innovations

THE SESSION IS EXPECTED TO RUN LONGER THAN THE OTHER SESSIONS. THEREFORE LUNCH WILL BE PROVIDED IN THE SESSION ROOM.

SUMMARY

The session will share insights into the development of the The Water Visions Lab Network (WVLN), introduce some of the partners and open up space for discussion, comments and feedback. The WVLN aims at integrating research with practical solutions towards identifying a feasible set of innovations to attain sustainable water solutions (sustaining environmental services, reducing threats to ecosystems while ensuring human water security) at the local level.
The WVLN will address three major innovation barriers: (1) long diffusion time of innovations, (2) lack of knowledge exchange between theory and practice and (3) lack of understanding of the implementation and adoption process. Within the WVLN framework, participants from different parts of society (public and private sector, scientific community, civil society, NGOs etc.) will come together and work towards developing water related innovations. Thus, the developed product will be based on a broad range of subjective preferences and concerns from different sectors and people from global, regional and local level. It will open up opportunities for wide range of technical, business, institutional and social innovations.

A06 Special Session: Implementing the Nexus in the MENA Region

SESSION CHAIR(S)
Rabi Mohtar,
Texas A&M University

Holger Hoff
Stockholm Environment
Institute (SEI)

INSTITUTION(S)
Stockholm Environment Institute (SEI) / Texas A&M University /
American University Beirut (AuB) / Chatham House /
German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE) /
The Cyprus Institute (CyI)

ROOM
Salon Haber

DATE
Monday, May 19
11:00 – 12:30

SUMMARY

This session focuses on implementation of the nexus concept in the MENA region, one of the world's hotspots of growing resource scarcity and climate change impacts, where food, water and energy constraints threaten to worsen human security and exacerbate conflict.
The session will take stock of existing and planned nexus activities and available data, information and knowledge in the region, as a basis for future coordinated activities within and across the different MENA countries.

Some of the issues to be discussed include:

- proposal for a regional data node, GIS and nexus hub
- potentially useful nexus indicators and metrics
- nexus economics, e.g. resource pricing, subsidies, incentives
- political economy of a nexus approach
- institutional analysis, opportunities for integration
- experience with nexus assessments, planning tools and integrated projects at various levels
- stakeholder engagement and dialogues
- regional cooperation
- funding opportunities

ROUND TABLE

- Rabi Mohtar (*Texas A&M, College Station, USA)*
- Holger Hoff (*Stockholm Environment Institute (SEI), Stockholm, Sweden)*
- Glada Lahn (*Chatham House, Royal Institute of International Affairs, London, UK)*
- Nadim Farajallah *(American University Beirut (AuB), Beirut, Lebanon)*
- Manfred Lange *(The Cyprus Institute (CyI), Nicosia, Cyprus)*
- Jean-Marc Faurès *(FAO, Water Development and Management Unit, Rome, Italy)*

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B01 Environment and Wellbeing: The Role of Ecosystems for Sustainable Development

SESSION CHAIR(S)
Francisco Meza,
Global Water System
Project (GWSP)

ROOM
Salon Lenné

DATE
Monday, May 19
13:30 – 15:00

1 Paul Lucas *(PBL Netherlands Environmental Assessment Agency, Bilthoven, the Netherlands)*
» Challenges and trade-offs of meeting long long-term sustainable development goals: reconciling poverty eradication with environmental sustainability

2 Andreas Neef *(Centre for Development Studies, University of Auckland, Auckland, New Zealand)*
» Resource Grabbing in the Food, Water and Energy Nexus: An Analysis of Discourses, Practices and Impacts

3 Eloise Biggs *(University of Southampton, Southampton, UK)*
» Environmental livelihood security: sustainable livelihoods and the environment nexus

4 Julie Snorek *(United Nations University Institute for Environment and Human Security, UNU-EHS, Bonn, Germany)*
» The production of contested landscapes: Changes to ecosystem services in the Sahel

ABSTRACTS

1 Paul Lucas, Detlef van Vuuren, Marcel Kok, Anne-Gerdien Prins, Rob Alkemade, Stefan van der Esch

The United Nations' discussions on defining a new set of long-term sustainable development goals focus on poverty eradication and sustainable development. The ambition to eradicate extreme poverty and ensure environmental sustainability brings the Water-Energy-Food nexus to the core of the debate. We use a quantitative pathway analysis to address how different combinations of technological measures and changes in consumption patterns could contribute to achieving a broad set of sustainable development goals, taking into account the interlinkages between them. The set of goals is based on existing international agreements, and could be considered as Sustainable Development Goals (SDGs) avant la lettre. It includes eradicating hunger, providing universal access to safe drinking water, basic sanitation and modern energy sources, avoiding further biodiversity loss, and limit global long-term mean temperature increase to 2 °C. The analysis shows that different pathways can be identified that achieve the goals simultaneously, but that marginal improvements will not suffice. The required changes include substantial transformations in both energy and agriculture, which go far beyond the currently formulated polices. Furthermore, the measures discussed put additional pressure on related challenges, such as reducing water stress and avoiding interference with the phosphorus and nitrogen cycle. The analysis shows that there is no fundamental trade-off between eradicating hunger and providing modern energy for all, on the one hand, and achieving environmental sustainability, on the other, while providing sustainable access to food, water and energy significantly reduces global child mortality.

2 Andreas Neef

The production of biofuels has become one of the most contentious issues in the food, water and energy nexus, raising a host of

photo © Sophia Paris/ UN

PARALLEL SESSIONS

B01 Abstracts

B01 Abstracts

ethical, legal and development concerns. Originally hailed for their potential of decarbonizing the energy sector, both first- and second-generation biofuels have come under increasing scrutiny for their potential of jeopardizing food security at the national and local level. Biofuels have also been identified as a major driver of land and resource grabbing in a number of developing countries, particularly in sub-Saharan Africa and Southeast Asia. Drawing on a case study from rural Cambodia and on a meta-analysis of the existing literature, this paper will discuss the impact of biofuel feedstock production on rural communities, common resources, and local food and water security. Findings suggest that the indiscriminate expansion of cropland for biofuel production by foreign and domestic investors risks undermining communal and individual land and resource rights among many rural communities in the Global South. The ethical implications of the mandatory biofuel policy of the European Union and recent shifts in the political and societal discourses in various OECD countries will be discussed in this light. It will be argued that crucial prerequisites for the development of "ethical biofuels" are that they do not compromise essential and basic human rights, such as access to food and water, or come at the expense of deforestation, biodiversity destruction and disruptions to major ecosystem services. In addition, there should be a fair distribution of costs and benefits among feedstock producers, processors and consumers. The paper will conclude with an assessment of the governance mechanisms and institutional frameworks that need to be put in place to produce and market biofuels that are both pro-poor and pro-environment.

3 Eloise Biggs, Bryan Boruff, Eleanor Bruce

Environmental livelihood security refers to the challenges of maintaining global food security and universal access to freshwater and energy without compromising livelihoods under variable climatic regimes. Environmental security is a concept complementary to sustainable development, and considers the increased vulnerability people have to certain environmental stresses, such as climatic change. Bridging links between the core component concepts of environmental security is integral to future human security, and in an attempt to create this bridge, the nexus approach to human protection has been created (Hoff, 2011), where water resource availability underpins food, water and energy security. This food-water-energy nexus has an influential role in attaining human security, yet little research has made the link between the nexus and livelihoods. In regions where livelihoods are dependent on environmental conditions, the concept of sustainable development is critical for ensuring future environmental and human security. Consequently, exploring the relationships between the nexus and sustainable livelihoods is required, particularly under a changing climate. This research investigates the potential to analyse environmental livelihood security issues at a regional level using mixed-methods to account for the spatial and temporal dimensions of environmental change. The research looks at developing a multi-level approach to differentiate between macro- and micro-scale environmental security, both of which are strongly influenced by the environmental and social geography of a region. For example, environmental insecurity, extenuated by the impacts of climate changes (e.g. more frequent extreme events), is often experienced more adversely by the poor and vulnerable of developing nations in regions where livelihoods have strong interdependency with the environment. The locational focus of the study is the Asia-Pacific region. Research presented will provide an overview of baseline information, key concepts and preliminary framework development to examine the geography of environmental livelihood security in the Asia-Pacific region through integrating nexus-thinking with the sustainable livelihoods approach.

This research is being funded by the World Universities Network (WUN) and the Universities of Southampton, Western Australia, Sydney and Auckland.

Hoff, Holger (2011). Understanding the Nexus. Stockholm Environment Institute, Stockholm. 52pp

4 Julie Snorek, Linda Moser, Fabrice G. Renaud

In the Sahel, land degradation is caused primarily by agriculture and overgrazing, and is exacerbated by high rates of rainfall variability. Access to ecosystem services provided by soil, water, and forests can shift between user groups (pastoralists and agriculturalists) based on how institutions manage land. Land use change, promoted by the greater frequency of drought events in the dryland systems of the Sahel, such as conversion of pasture to cultivated land has the tendency to further degrade soil, increase runoff, and create conflict with users who rely on pastoral resources. While regenerative methods such as planting nitrogen-fixing trees in degraded areas has promoted what some have called the "greening" of the Sahel, such change is not widespread and does not necessarily resolve land use conflicts. Using remote sensing methods for change detection and time series analysis, as well as qualitative analysis of environmental histories, this article evaluates the inequities of current changes to ecosystem services in multiple rainfall zones in Niger, evaluated for both pastoral and agro-pastoral livelihoods.
The case study focuses on Tahoua, Niger using a mixed method approach. Remote sensing high-resolution images such as Quickbird-2, WorldView-2 and RapidEye allow for the detection of adaptation and changes to specific ecosystem services (enclosures in pastoral areas or around seasonal lakes). The temporal development in these regions was then analyzed for a period of 14 (2000 – 2013) years using time series from the Moderate Resolution Imaging Spectroradiometer (MODIS). Satellite images demonstrate the detection of changes to ecosystem services, like the increase of gardening, the presence/absence of fences, or the dynamics of seasonal lakes. In the same spatial region, we chose three villages in the different rainfall zones and performed 117 qualitative and expert interviews to assess the changes to ecosystem services for users within both rain-fed agricultural and pastoral systems. Results over a 14-year timescale show that cultivation is spreading even in the highly contested, government-designated 'pastoral zone.' Moreover, irrigated agriculture has grown significantly around ephemeral lakes in the same timescale. Most users perceive that the benefits supplied by ecosystems in the Sahel are waning as a result of multiple forces. The dominant perception is that degradation of soil and pastoral resources is promoted by cultivation. These 'divergent' adaptations are supported by inequitable or corrupt institutional practices, which are shifting the entitlements to water-based shared ecosystem services and enabling dominant groups to enclose and cultivate such areas. Understanding and evaluating changes to ecosystem services using this combined method of remote sensing and qualitative research can support and promote sustainable ecosystem management, especially in the context of climate variability.

B02 Governing the Nexus: Tools and Case Studies

SESSION CHAIR(S)
Joyeeta Gupta,
Global Water System Project (GWSP)

ROOM
Salon Rheinaue

DATE
Monday, May 19
13:30 – 15:00

1 Elisabeth Ehling *(Institute of Environmental Systems Research, Osnabrück, Germany)*
» The importance for combining governance modes for sustainable management of water-energy and food.

2 Elizabeth Curmi *(University of Cambridge, Cambridge, United Kingdom)*
» China's water-energy nexus for integrated resource policies

3 Nadim Farajalla *(Climate Change and Environment in the Arab World Program, Issam Fares Institute for Public Policy and International Affairs, American University of Beirut, Beirut, Lebanon)*
» The Lebanese Water Energy and Food Nexus: A Policy and Institutional Analysis

4 Pranietha Mudliar *(School of Environment and Natural Resources, The Ohio State University, United States)*
» Role of Heterogeneity in Collaborative Water Management: Case Studies from India and the United States

ABSTRACTS

1 Elisabeth Ehling

Current and Future Demands on the water, but also changes in the environment can lead to problems. It is society's needs , environmental claims and to maintain security of resources in balance. These challenges perceive different institutions , which follow different objectives and rules. Thus there is a need for improved collaboration and networking across the water sectors such as utilities, waste management , water conservation, power production, and flood and drought protection. This work handels with the influence of the governance modes and how they work together´and influence each other.
Objectives and methods
The project examines how an sustainable water management might look like. It is judged as the water sectors work together and how they can be controlled. The following aspects are taken into account, which are important for the sectors of water use, water conservation and flood and drought protection: Geographic space , legal responsibilities , political skills , organizational structures and management these sectors. The institutions and actors are involved with workshops and focus groups in research. In addition, strategies and instruments are proposed that are suited to support the transition from a sectoral to an integrated water policy.
The governance modes can be found in symbioses but never without the other modes. The dominant mode tackles the others, but in which way and how- this will be analyzed. The ten case studies are located in Germany, Netherlands, Spain, Hungary, Australia, South Africa and China. Some have been studied for many years and have a wealth of detailed information. Others studies have only been started in the past few years. The insights from comparing these case studies are the basis for the analyses of the hypothesis: Sustaining change and stabilizing an adaptive and integrated and thus sustainable governance and management approach require an integration of governance modes.
The case studies are distributed across the world and represent a wide range of ecosystems, management regimes, and resilience issues. They range in extent from the hierarchical dominated Germany to the network dominated Netherlands, and from different regimes from the Communist state to a federal parliamentary democracy and a Commonwealth realm. The range of social systems and resource-use types is correspondingly broad.
5.References11.Meuleman, L. (2010): Metagovernance of climate policies: Moving towards more variation. Paper presented at the Unitar/Yale conference, Yale University, New Haven, Conneticut, 17-19 September 2010.17.Pahl-Wostl, C., Kranz, N. (2010): Water governance in times of change. Editorial to special issue. Environ. Scie. & Policy, 13, 571-581

Acknowledgement
This is the first DFG (German Research Foundation) funded project in the field of water research using a system oriented concept in which social and natural science combine an interdisciplinary milestone.

2 Ying Qin, Elizabeth Curmi, Grant Kopec, Julian Allwood, Keith Richards

Due to population growth and economic development, demand for energy in China is expected to increase by 80% from 2013 to 2035. China plans to meet this increase by diversifying its energy mix through increasing nuclear power generation and through shale gas extraction, whilst also sustaining its use of coal. Water is required for extraction, processing and refining of fuel sources and for cooling in power generation, but most energy policies do not take account of water demands. The water-in-energy interaction is particularly important in China, since it has an uneven distribution of water, which is leading to environmental pressures particularly in northern provinces. To address water issues, China has developed the "3 red lines" water policies; one of these aims to reduce the amount of water used by the industrial sector, of which the energy sector is a part. However since energy and water policies are not integrated, this industrial water policy may conflict with future energy plans.
ForeseerTM, an online web-based tool that uses Sankey diagrams to trace the connections between different resources, is used to analyse the connections of water and energy in China. The tool presents (1) a dynamic energy Sankey diagram that traces over time the demand and supply of energy from its source to the final services under different IEA scenarios, (2) the corresponding water withdrawals and consumption for energy sector activities and (3) an analysis of the amount of water withdrawn by the energy sector as compared to the total water allowed by the industrial sector under the "3 red lines" water policy. Rather than assume a set of fixed future technology pathways, users of the tool can choose amongst a suite of technologies, for example deciding whether new coal power plants will use either wet tower or dry cooling.
The results show that even though coal continues to be the dominant source of energy, there is an expansion of nuclear power to help meet increased demands for electricity. Some of these new plants must be built inland, so the demand for cooling water will increase. Compliance of the energy sector with the industrial water policy depends on the technology used, and on increased recycling and reuse of water. For example, under the current energy policy scenario and with current technology, the energy sector would utilise nearly half of total allowed industrial water if all new inland nuclear plants use wet tower cooling, however they will not be able to comply with the policy if they use once-through cooling.
This analysis and its representation helps decision makers and businesses to visualise and understand the connections between water and energy resources and the importance of developing an integrated policy approach for these resources. It also highlights different energy technological options and their trade-offs with water withdrawals and consumption.

3 Nadim Farajalla, Patricia Haydamous, Rana El Hajj, Silva Kerkezian, Charbel Rizk

Lebanon is facing water, energy and food security challenges aggravated by population growth, high population density, high urbanization rate, and climate change. Recent national policies have been put to ensure meeting the minimum demand for and continuous supply of resources, but the country is still facing heightened stress on resources and at times shortages.
This policy research paper aims at evaluating the depth of interconnectedness between Lebanese policies and within the institutional frameworks governing the water, energy and food (basically agriculture)- sectors, to place Lebanon on a nexus scale to policymaking. This is

B02 Abstracts

achieved by highlighting the strengths and weaknesses in governmental institutions and governance processes that hinder or enable an integrated approach to policy planning. The paper is based on desktop reviews of official mandates and documents and semi-structured interviews with key people in ministries and governmental agencies.
The identified direct stakeholders to the water energy and agriculture sectors are the Ministries of Energy and Water; Agriculture; and Environment with all their corresponding institutional bodies. Indirect stakeholders addressed are the Ministries of Finance; Economy and Trade; Social Affairs; and Public Health as well as the Council for Development and Reconstruction and various national committees and international organizations. Integration assessment was based on first, analyzing the coordination level of the policymaking bodies within one ministry, and across relevant stakeholders; second, on the interconnections between sector strategies.
It was found that the governing body, by law, seems to be quite structurally integrated among its institutions where most of the concerned ministries have a link to the three sectors; however, this is not translated in the actual governance as most plans and policies only reach out across two sectors and in some cases even remain within one sector. This is due to many factors mostly related to the policy planning processes such as personnel, functionality, the complicated cross-ministerial communication protocol, and the quality and uniformity of shared data.
A more integrated policy development process could be realized through improved inter-ministerial communication protocols and building the capacity of personnel in essential knowledge and skills. Thus a nexus approach could be achieved by enabling existing bodies rather than creating new ones.

4 Pranietha Mudliar

In developed and developing countries, collaborative partnerships have emerged to address water quality and quantity. The U.S. Federal government spends over $200 million annually each year to address non-point source water pollution through the Clean Water Act Section 319, while states spend millions more (Hardy and Koontz, 2007). In India, over $550 million is invested annually in water projects by the Indian government as well as international donors (Kerr 2006). A key rationale for these approaches is the notion that “community” is better than “centralized” governance. However, the reality is that communities are not homogeneous entities.
Communities are divided across class, caste, race, gender, resources, interests, and values. Scholars of collective action and common pool resource management have identified heterogeneity as variously helping or hindering success. These inconsistent results stem from a lack of specificity regarding the dimension of heterogeneity, and the context. In this proposal, I identify conditions and incentives for heterogeneous communities for developing effective natural resource management policies. In particular, I focus on which institutional mechanisms best enable heterogeneous communities undertake successful collective action. This research will contribute to the Common-Pool Resource Theory, and more pressingly, the design of effective natural resource management policies in heterogeneous communities. This research will be conducted in India and Appalachia, U.S., therefore, studying institution formation in different contexts will illustrate strategies developed by communities to mediate the effect of heterogeneity. This research can contribute towards formulating solutions for building stronger institutions with government support to improve rural livelihoods. The policy implication is that attributes of actors, and external agency support are highly relevant for natural resource governance. This implication can be applicable in both India and the United States.

B03 Special Session: Sustainability – the Hidden Dimension of the Water-Energy-Food Nexus

SESSION CHAIR(S)
Thomas Chiramba

ROOM
Saal Reger

DATE
Monday, May 19
13:30 – 15:00

INSTITUTION
United Nations Environment Programme (UNEP)

1 Eric Hoa *(United Nations Environment Programme, Nairobi, Kenya)*
» UNEP’s engagement in the Water-Energy-Food Nexus

2 Louise Karlberg *(Stockholm Environment Institute, Stockholm, Sweden)*
» Using a Nexus Approach to Support Development and Environmental Planning in Ethiopia

3 Representative of *The Landscapes for People, Food and Nature Initiative*
» The Landscapes for People, Food and Nature Initiative

4 Richard Taylor *(International Hydropower Association)*
» The Hydropower Sustainability Assessment Protocol

SUMMARY

Water, energy and food are interlinked. Water plays a crucial role in the delivery of many ecosystem services, including provisioning services such as production of food crops and bioenergy, but also cultural, regulatory and supporting services. Leaving out marine food and energy production, land is a crucial element as well in the water-energy-food nexus. Terrestrial and freshwater aquatic ecosystems provide the enabling environment for water flows, food security and energy provision, but are at the same time also impacted by the many processes in the water-energy-food nexus. A better understanding of the ecosystems dimension of the water-energy-food security nexus is now required to help address critical issues and identify sustainable solutions. Major drivers of the water-energy-food nexus are the various fuel, food and finance crises, population growth with rapid urbanization, consumption patterns, land degradation and climate change. Hence, if policy dialogues on the nexus are to be effective, livelihoods and the environment need to be taken into consideration.

While the various initiatives have helped to start the dialogue, in practice the sectors involved stay largely in their own domains, steered by their own interests and restrictions, and contributions to the nexus tend to be sector-specific. In addition, there is the issue of scale, as impacts of linkages tend to have cross-boundary impacts, whereas international governance is highly challenging at the least. However, if the nexus is to achieve sustainable livelihoods, a focus on ecosystems might be more effective in creating a common vision in the nexus.

B04 Implementing the Nexus at Various Scales: Transboundary Challenges and Solutions

SESSION CHAIR(S)
Charles Vörösmarty, Global Water System Project (GWSP)

ROOM
Salon Haber

DATE
Monday, May 19
13:30 – 15:00

1 Sergiy Moroz *(European Water Partnership, Brussels, Belgium)*
» Water Stewardship Approach: Innovative Tools for Resource Efficiency

2 Emma Li Johansson *(Department of Physical Geography and Ecosystem Sciences, Lund University Centre of Excellence for Integration of Social and Natural Dimensions of Sustainability, Lund, Sweden)*
» Virtual land and water flows from export-oriented food and energy production in Africa

3 Roland Schulze *(University of KwaZulu-Natal, Pietermaritzburg, South Africa)*
» Modelling energy, agricultural and urban water demands and supplies in the Waterberg region of South Africa: A case study of interactions, tensions and surprises under projected development and climate change scenarios

4 W.N.M. Van der Krogt, H.J.M. Ogink *(Deltares, Delft, the Netherlands)*
» Insights in the water-food-energy nexus in the Nile Basin with the new Eastern Nile Water Simulation Model

ABSTRACTS

1 Sergiy Moroz

Private and public sectors have acknowledged that water stewardship emphasizes balanced solutions for resource efficiency that reconcile sustainable use of water with equitable and responsible governance and economic benefits . To begin the journey towards water stewardship, water users must address all risks including those “beyond the fence” and not only on-site. Building up a water stewardship scheme supports the active involvement of the private sector on river basin scale, while providing positive incentives to change water management practices and governance.
An intensive stakeholder process organized by European Water Partnership, and with full recognition by EU authorities, gave way to the European Water Stewardship (EWS); established as the European “regional initiative” of the global Alliance for Water Stewardship (AWS). EWS was envisaged a cohesive system for business and agriculture to assess, improve, and communicate sustainable water management practices. In this global context, EWS promotes EU processes, including compliance with the Water Framework Directive and aligning private water users with its goals.
The EWS standard, equivalent to the global one, outlines concrete criteria for sustainable management centered on four principles: water availability, water quality, ecosystem protection, and good water governance. Both regional and global schemes include a standard, a certification, and communication scheme that make “business sense” for adherents by offering tried-and-true steps to secure water availability for the future.
Assessment with a water stewardship standard allows water users to identify all physical, regulatory, and reputational water-related risks, both on-site and within their catchment and supply chains. Developing long-term response measures to any significant gaps in water management identified, if possible by collaborating with other catchment users, equates to improvements to local ecosystems with real impacts on sustainable water management in Europe.
While European businesses are encouraged to use the EWS standard as a tool for internal water assessment, third-party certification with the standard is an option which allows companies to demonstrate their operational water performance, which acts as a driver to improve water management practices.

References:
CDP Global Water report 2013. Moving Beyond Business as Usual. A Need for Step Change in Water Risk Management.
The AWS International Water Stewardship Standard. Beta Version for Stakeholder Input and Field Testing. Version 04.03.2013. Alliance for Water Stewardship.
European Water Stewardship Standard. V4.8 December 2012. European Water Partnership.

B04 Abstracts

2 Emma Li Johansson, Jonathan Seaquist, Kimberly Nicholas

As land and water are becoming increasingly scarce and contested resources, foreign investors are acquiring land in developing regions for export-oriented crop production in order to secure their future food and energy demands. The local to global impacts from such large-scale land changes are beginning to receive attention in the scientific literature. Many studies have analyzed datasets of global large-scale land acquisitions (LSLA) in order to reveal who is acquiring land, as well as the location and purpose of these acquisitions. Some studies have also analyzed the virtual flows of water that are embedded in land exports. However, few have linked the trade between nations with different biophysical and economic conditions.
The aim of this study is to quantify the magnitudes of virtual export of land and water from African countries, for food and energy production, and relate this to each nation’s water and land availability.
In order to achieve this, we use the Land Matrix database for quantifying the virtual flow of land between nations. The flow of land is thereafter related to its crop- and nation-specific water footprint and categorized into blue, green, and grey water, and visualized using network analysis. We categorize each crop into food-, fuel- and flexible- (multi-purpose) crop groups, in order to distinguish the purpose of production. Virtual water flows are then related to water scarcity in each nation in order to highlight where virtual water exports might cause negative impacts on ecosystem services.
Our results from initial data show that the majority of crops grown (or planned to be grown) on acquired land in Africa are for food and fuel production, with the main crops being jatropha, maize, oil palm, sugarcane and rice. In total, agents from 65 countries have acquired land in Africa (also including African investors). Most land is acquired for flexible crops, covering 12.8 million hectares. India acquire 13% of this land, followed by South Korea (12%) and Malaysia (9%), as well as the US, and countries in Europe and the Middle East. The total area acquired for food production is 7.3 million hectares, mainly by India (19%), the UK (12%), and the US (11%) as well as by Asian and Middle Eastern countries. A total of 6.4 million hectares have been acquired for fuel production. These acquisitions are dominated by Israel (35%), the UK (15%), and the US (12%), while the others are mainly European.
Large-scale production of such crops might have implications for local water availability due to their high water demand.
These initial results will be updated with the most recent data of land acquisitions in Africa. In order to further explore this aspect, we plan to develop water footprint estimates associated with these land acquisitions. This will enable us to determine the extent to which water-intensive crops are grown in countries with seasonal or annual water scarcity and therefore incur large impacts on ecosystem services.

B04 Abstracts

3 Roland Schulze, Nicholas Davis

In a largely coal dependent and energy hungry South Africa, major new energy development is currently underway in the semi-arid, in places severely degraded and agriculture dominated, Waterberg region of the country, with developments including the opening of new coalfields, construction of large new power stations, expansion of existing small urban centres and proposals, over the next 20 years, for a new town and a petrochemical plant. Compounding these developments is that irrigation demands from the existing storage dam are already high, that much of the area is endorheic, i.e. consisting of internal drainage only, and that the water for proposed developments is to be sourced externally to the catchment via major inter-basin transfers from 200 km away. This entire system has been configured and modelled with the daily time step and process based ACRU agrohydrological model for present landscape and climate conditions and for a range of development projections including water flows and transfers, urban expansion including effects of return flows on downstream flows and the performance of an existing major dam used for irrigation. Results show that the catchment's hydrology is largely insensitive to present-day rainfed agriculture, while being highly sensitive to land degradation and irrigation water demands, and that the proposed water engineered system, especially with water sourced externally via inter-basin transfers, often completely dominates the hydrology of the catchments, be it under present or projected climate scenarios. These findings emphasize not only interactions between natural and development dominated catchments, but also highlight potential tensions/stresses when different sectors make competing demands for water. Furthermore, in the catchment surprises emerge as to the dominance of climate change vs land use vs water engineered systems within different parts of the catchment.

4 W.N.M. Van der Krogt, H.J.M. Ogink

In the Nile basin, food and energy sectors strongly compete for water. Coping with this water scarcity challenge is complicated by the trans-boundary setting and insufficient shared insights in water availability and allocation possibilities within the basin. To support the dialogue between sectors and countries, the Eastern Nile Technical Regional Office (ENTRO) has developed the Eastern Nile Water Simulation Model (ENWSM).
The ENWSM is a flexible water balance model powered by the river basin planning and management software RIBASIM (River Basin Simulation Model) and covers the hydraulic infrastructure of the Eastern Nile (EN) with the Bahr el Jebel at Mongalla (South Sudan) as the upper and the High Aswan Dam (Egypt) as lower boundary. A model network schematization has been made which includes all current and identified potential basin infrastructure and water related activities in the EN sub-systems. These can be activated by the user to simulate the system behaviour under current conditions and development and climate change scenarios. The hydrological boundary conditions consist of monthly rainfall, evaporation and river flow series. Available series have been completed/extended to the period 1900-2002. Model calibrations and verifications have been carried out on reproduction of natural flows and the current conditions. The potential of the model is illustrated by scenario analysis of the EN basin for a number of identified scenarios, measures and strategies on critical EN issues like water infrastructure development and climate change. Simulations with the model have further substantiated existing assumptions and provided new insights regarding the influence of infrastructure on the system as a whole and for each EN country (Ethiopia, South Sudan, Sudan and Egypt), for example: Change in flow regime in the EN; Increase / decrease in hydro-power production; Save water losses for the basin as a whole; Increase potential for crop production; Sediment capture in the Ethiopian reservoirs.
The model is now available to universities and research centres in the EN countries, which can use the model to further improve and explore alternative policy options. As a common reference and analysis framework, the ENWSM can facilitate the dialogue and cooperation among countries in the EN basin. The presentation will present the setup of the ENWSM, insights on the water-energy-food nexus in the EN, and opportunities for future research to improve and apply the model.

B05 Special Session: The Nexus and Climate Change Adaption

SESSION CHAIR(S)
Young-Il Song

ROOM
Salon Arndt

DATE
Monday, May 19
13:30 – 15:00

INSTITUTION
Korea Environment Institute (KEI)

1 Jong Ho Ahn *(Korea Environment Institute, Seoul, Republic of Korea)*
» A Preliminary Assessment of Water Security and its Nexus to Energy in Korea

2 Seungjun Lee *(Korea Environment Institute, Seoul, Republic of Korea)*
» An Ecological Perspective on Nexus and Climate Adaptation

3 Charles Rodgers *(Stockholm Environment Institute, Bangkok, Thailand)*
» Pricing Asymmetries Between Energy, Food and Water in the Nexus: Problem or Opportunity?

4 Rabi Mohtar *(Texas AM University, College Station, United States)*
» Tools to Enable Nexus Approaches

5 Conway, Declan *(Grantham Research Institute for Climate Change and the Environment, London, United Kingdom)*
» Climate variability and Southern Africa's food-water-energy Nexus

SUMMARY

Human-induced climate change is making increasingly significant and lasting impacts on various aspects of our societies. The Fifth IPCC Assessment Report informed that the global surface temperature, by the end of the 21st century, is likely to increase more than 1.5°C relative to a reference period of 1850 to 1900. Beyond 2°C increase can threaten 20~30% of the species on the Earth with danger of extinction. The unprecedented extreme weather events, which are partially attributable to the climate change, such as heat waves, floods, and drought, are occurring around the world. Despite the current global cooperations and efforts to mitigate greenhouse gas emissions, however, adaptation will be necessary to address impacts resulting from the unavoidable climate change due to past emissions and interactions between climate and other stressors.
A number of organizations and researchers as well as government policies in recent years have been focusing on adaptation taking into account the significant impacts of climate change. This special session is intended to discuss the current states and challenges of our societies facing upcoming effects of climate change, and share adaptation experiences at local, national, or global scales with regard to water, energy, and food nexus. By discussing and sharing experiences, we expect to formulate required future strategies, actions, and local or international collaborations on water, energy, and food in a changing climate.

B05 Abstracts

1 Jong Ho Ahn, H. Kim, E.S. Cho

Because surface water from rivers and dams accounts for 89% of the total water supply in Korea, climate change can significantly affect the national water security. Moreover water availability is the primary concern for the hydroelectric power generation. So, it is necessary to figure out the impact of climate change on water system and prepare appropriate measures. In this study, authors assessed the vulnerability of water supply system to climate change and roughly investigated the water-energy interrelationship in Korea. Various proxy variables for 3 compartments – exposure, sensitivity and adaptive capacity – were selected throughout the water supply system. Then authors calculated the vulnerability score for 164 local districts in Korea. Water supply systems in urban cities were more resilient to climate change than others. Especially, metropolitan cities such as Seoul exhibited low vulnerability score. However those in small inland counties and coastal areas showed greater risk. In addition, authors found a statistically-significant correlation of vulnerability score with low population density and high level of consumer complaints. Recently, water and wastewater managers in Korea started paying attention to energy use in their facilities.

The electricity use for water abstraction and pressurization was greater than that for water treatment process. In 522 drinking water treatment plants (DWTPs), the average electricity use was 0.15 kWh/m3 and 0.21 kWh/m3 for regional waterworks and local waterworks, respectively. For public sewage treatment plants (SWTPs), the electricity bill accounts for about 20% of total O&M cost and it rises 10.6% every year. The electricity use increases with flow rate, chemical oxygen demand (COD) of influent and the application of tertiary treatment process. Most of the SWTPs with membrane filtration show poor energy efficiency. Water use in energy sector has received less attention than energy use in water sector. First, the share of hydroelectric power is very low in Korea. Second, major nuclear or thermal power generation plants are located at coastal areas and they use seawater for cooling. But it should be noted that hydropower plays an important role during peak demand times. Korean government prepared comprehensive climate change adaptation plan in 2008 and water sector is one of the main focus. To mitigate greenhouse gas emission, water and wastewater treatment plants make efforts to improve energy efficiency. For SWTP, government set up the challenging target which raises the energy independence ratio up to 50% by 2030. Still, the policy measures do not cover the whole water areas but focus mainly on floods and droughts.

The high uncertainty in the climate change projection prevents policy makers from implementing the measures. Therefore, it is necessary to broaden the viewpoint to other water areas such as water quality and aquatic ecosystem. For nexus perspective, the intra-dependency among various water areas as well as inter-dependency between water and other sectors needs to be investigated more comprehensively. Inter-disciplinary collaboration for data collection could be the first step.

2 Seungjun Lee

As climate change has been accepted scientifically and socially as a reality, a number of countries and local governments in recent years have been preparing adaptation strategies and action plans against climate-driven natural and socioeconomic changes to come. From an ecological perspective, climate change alters structures and functions of ecosystems, which are supporting human societies by providing ecosystem services including provisioning, regulating, supporting as well as cultural services. The climate-driven alteration of ecosystems is followed by spatial movement, adaptation, or extinction of species. In those cases, the complex interactions between a new species composition and abiotic components such as water and soil directly or indirectly influence the quality and quantity of ecosystem services. Korean peninsula is very likely to face this problem in the upcoming climate change. The complex interconnectedness among mountain ridges, forests, and aquatic ecosystems calls for urgent adaptation actions to climate change, focusing on conservation and restoration of ecological network. In addition, the intact ecology of the demilitarized zone (DMZ) between South and North Korea may not be adaptable to the climate change with the current DMZ management. The ecological security of the DMZ entails political issues between South and North Korea as well as requires international cooperation for peaceful resolution to conserve the nature of the region.

B05 Abstracts

3 Charles Rodgers

The concept of the Water-Food-Energy nexus as an analytical framework for understanding and improving the efficiency of resource use across sectors gained increasing visibility through the World Economic Forum Water Initiative[1], the Bonn2011 Nexus Conference[2] and related forums. The nexus, with roots in systems analysis, is a shorthand for the multiple linkages, trade-offs and synergies between water, food and energy; and integrated analysis can in principle support improved resource allocation decisions, including impacts on ecosystem services and the poor. Although the nexus has clearly entered mainstream development discourse, the effectiveness of nexus-based analysis in improving resource decision-making has yet to be established empirically. To that end, the Stockholm Environment Institute (SEI) is currently applying nexus approaches to a range of projects in Africa and the Middle East, western USA, China, India and the Mekong region.

One issue that has complicated nexus-type analysis is the pricing of resources. While the prices of energy and primary food commodities are established in regional and international markets, water is not priced at all in many uses, and when it is (as in municipal water tariffs or irrigation fees), the price often diverges substantially from both cost of provision and economic value in alternative uses. The failure to make reasonable assumptions about the economic value of water has contributed to many questionable resource use decisions, including (among others) large-scale biofuels production and natural gas extraction via hydraulic fracturing (“fracking”), each of which involve extremely high levels of water input per unit of energy obtained. For example, first generation biofuels production requires roughly 180 m3 of water per KwH compared to 60 m3 per KwH for hydropower and 2 m3 per KwH for coal-fired thermal. Difficulties in establishing the economic value of water thus appear as a potential obstacle in utilizing nexus approaches to natural resource decision-making. However, nexus-based analysis can also provide the means for establishing the value of water, particularly in situations where it is either unpriced or subject to unrealistically low tariffs, through the exploration of alternative water allocation scenarios.

[1]World Economic Forum (2011): Water Security: The Water-Food-Energy-Climate Nexus. Island Press.

[2]Bonn2011 Conference: The Water, Energy and Food Security Nexus – Solutions for a Green Economy. 16-18 November 2011.

4 Rabi Mohtar

Water, energy, and food resources are interrelated and share unprecedented challenges triggered by growing population, economic crises, hunger, climatic variability, etc. Addressing these grand challenges requires holistic approaches and shift from business as usual in the way we manage and allocate resources. This presentation explores attributes for holistic and integrative tools to allow us to quantify tradeoffs in policies and practices among these critical resources and explores research opportunities towards new nexus tools.

5 Declan Conway

Numerous challenges coalesce to make Southern Africa emblematic of nexus issues. Rainfall and river flows in the region show high levels of variability across a range of spatial and temporal scales. With future climate change, rainfall is likely to decrease and rising temperatures may bring higher rates of evapotranspiration. The region’s economy is closely linked with the rest of the African continent and, in the 15 countries of Southern Africa, climate sensitive food products are the largest item of trade. Examples of the linkages between the climate and the food-water nexus of South Africa include a 7% drop in GDP during the 1983 El Niño year, and climatic fluctuations resulting in GDP fluctuations of up to US $5 billion (Jury, 2002). Economic modelling studies in Malawi and Zambia have shown that the severe 1992 drought caused an approximate 7-9% drop in GDP and adversely affected household poverty (Thurlow et al., 2012). In this paper, we present a review of key literature on the region’s nexus and empirical analysis of national level data on climate, water resources, crop and energy production, and economic activity for the region. Our aim is to examine the role of climate variability as a driver of production fluctuations in the nexus, and to improve understanding of the magnitude and temporal dimensions of their interlinkages.

C01 Special Session: Towards UN-coordinated Support to the Implementation of the Nexus

SESSION CHAIR(S)
Thomas Chiramba

ROOM
Salon Arndt

DATE
Monday, May 19
15:30 – 17:00

INSTITUTION
United Nations Environment Programme (UNEP)

1 Michela Miletto *(UNESCO/World Water Assessment Programme, Perugia, Italy)*
» Facing the challenges - the role of the United Nations system and the international community

2 Igor Volodin *(United Nations Industrial Development Organization, Vienna, Austria)*
» The relationship of water and energy with industry

3 Annukka Lipponen *(United Nations Economic Commission for Europe, Geneva, Switzerland)*
» Assessing the water-food- energy-ecosystem nexus in transboundary basins

4 Olcay Unver *(Food and Agriculture Organization of the United Nations, Rome, Italy)*
» Water for energy and the linkages to food security

SUMMARY

In view of the post-2015 Sustainable Development Goals, likely to include increased access to water, energy and food services, the United Nations agencies need to inform decision-makers (across sectors), stakeholders and practitioners about the inter-linkages, potential synergies and trade-offs, and to highlight the need for appropriate responses and regulatory frameworks that account for both water, energy and food securities. In practice, different people in different departments, if not different agencies, are responsible for funding decisions, project development and policy-making. This holds true at all levels of administration and explains why integrated energy, food and water policies are rare. However, in the work of the United Nations system, other international regional organizations, development banks and bilateral development agencies, many programmes and projects exist aiming to address the interplay between the sectors. This points to a project-by-project approach to deliver context-specific support. The coordination mechanisms of the United Nations system, UN-Water and UN-Energy, continue to play leadership roles in providing a platform for cooperation with civil society to formulate coherent and integrated responses. The recognized need for separate sustainable development goals dedicated to water, food and energy security, which must be independent of each other but closely related and coordinated, provide an excellent opportunity for UN-Water and UN-Energy to assume a strong leadership and facilitatory role. The session provides a comprehensive overview of major and emerging trends around the world, with examples of how some of the trend- related challenges have been addressed by the UN agencies, their implications for policy-makers, and further actions that can be taken by stakeholders and the international community.

C02 Special Session: Institutional Capacity Development for Advancing the Nexus Approach

SESSION CHAIR(S)
Jens Liebe

ROOM
Salon Rheinaue

DATE
Monday, May 19
15:30 – 17:00

INSTITUTION
UN-Water Decade Programme on Capacity Development (UNW-DPC)

1 Zafar Adeel *(UNU-INWEH, Hamilton, Canada)*
» Addressing Capacity Needs for Water, Food and Energy Security

2 Uta Wehn de Montalvo *(UNESCO-IHE, Delft, Netherlands)*
» Integrating knowledge and innovation for strengthening institutional capacity: Water sector lessons for the nexus

3 Lars Ribbe *(Institute for Technology and Resources Management in the Tropics and Subtropics Cologne University of Applied Sciences, Cologne, Germany)*
» *Addressing the W-E-F Nexus in postgraduate Education*

4 Daniel Tsegai *(UNW-DPC, Bonn, Germany)*
» Institutional Capacity Development for advancing the nexus approach: Cases of UN-Water initiatives

SUMMARY

The water, food and energy sectors are inextricably linked. Action in one sector may be felt across the other two and beyond, including climate and biodiversity, and call for management responses which maximize overall benefits. The nexus perspective is particularly instrumental in improving our understanding of the trade-offs and synergies in the management of these interdependent systems and moving towards interdisciplinary approaches. The lack of institutional capacities is frequently identified as the biggest hindrance to implementing and fully benefiting from the nexus approach. Advancing the nexus approach requires, among other things, capable institutions with a thorough understanding of the nexus that cut cross disciplines and bridge beyond disciplinary silos. Institutional capacity development - which captures a combination of organizations' capacities and the creation of an enabling environment for a proper utilization of a gained knowledge - is critical in order to build an informed and functional framework for the realization of the nexus approach. An effective nexus approach can only be achieved by bringing together the sectors which could benefit from mutual cooperation and raising the capacities of the relevant stakeholders at all levels. The cross-cutting nature of the nexus approach requires an optimal mix of competent individuals and an enabling environment to implement and sustain the interdependence between and among the sectors. This session aims at dealing with issues of capacity development to implement and boost the effectiveness of the nexus and raise the awareness of stakeholders to recognize the benefits of the nexus approach. The session will benefit from international experts on the nexus approach who will highlight the role of capacity development. The session targets policy makers, academics and stakeholders at all levels to allow interaction and the exchange of experiences and examples of best practices.

C02 Abstracts

1 Zafar Adeel

Developing countries typically have low resilience for absorbing societal shocks related to the security and supply of either water, food or energy. Reducing and more polluted water resources, escalating food prices and chronic energy shortages paint a picture of escalating crisis. More critically, however, the societal vulnerability is put to the maximum test when these three issues converge geographically, temporally, or both. The most significant and effective response to such situations in the future is to help build the capacity of developing countries to better understand, plan for and respond to the "nexus" security issues. Given the state of practice around the nexus, which is mostly absent at a governance level, capacity needs are recognized both at the policy and implementation levels.

2 Uta Wehn de Montalvo

There has been a steady rise of knowledge and capacity development (KCD) interventions over recent decades, including those aimed at strengthening institutional capacity. However, anecdotal evidence, experience and research suggest that often little change occurs in what organizations do as a result of such KCD efforts, certainly within the limited time frame of dedicated projects. Focusing on the water sector and based on recent events held at UNESCO-IHE that brought together international expertise, as well as research undertaken in developing countries, this presentation i) uses concrete examples to demonstrate how knowledge and innovation can be integrated successfully for institutional strengthening and ii) draws lessons for KCD priorities to strengthen institutional capacity for the Water-Energy-Food nexus.

3 Lars Ribbe

Postgraduate education is an important step in forming future professionals and decision makers. So far there are few educational programs which explicitly address the Water Energy Food Security nexus, even though it is widely recognized as an important concept. The presentation explores options to integrate the nexus concept into existing programs and to link different sectorial postgraduate programs creating added value through intersectoral, interdisciplinary and intercultural elements of education.

4 Daniel Tsegai

With global trends such as population growth, climate change and the changing consumption behavior of society, the demand for food, water and energy will dramatically increase, compromising the sustainable use of vital natural resources. Hence, it is important to raise awareness of stakeholders at all levels on the interdependencies of the sectors and the recognition of the economic and sustainability benefits of the nexus perspective. Based on UN-Water initiatives on cross-cutting issues such as 'safe use of wastewater in agriculture' and 'national drought management policies', the presentation will emphasize the role of capacity development for advancing the nexus approach.

C03 Special Session: Ecosystems and their Services in the Nexus

SESSION CHAIR(S)
Claudia Ringler

ROOM
Saal Reger

DATE
Monday, May 19
15:30 – 17:00

INSTITUTION
CGIAR Research Program on Water, Land and Ecosystems (WLE)

1 Tracy Baker (*International Water Management Institute, Addis Ababa, Ethiopia)*
» Incorporating gendered landscapes into physically-based models via Participatory 3-D Mapping

2 Guillaume Lacombe *(International Water Management Institute, Vientiane, Lao PDR)*
» Simple power-law models to predict flow metrics for water resource and risk management along the Mekong tributaries

3 Martin Volk *(Helmholtz Centre for Environmental Research (UFZ), Department of Computational Landscape Ecology , Leipzig, Germany)*
» *Ecosystem services and river basin models*

4 Hua Xie *(International Food Policy Research Institute, Washington D.C., the United States)*
» Implications of socio-economic development and climate change on water quality – a global assessment

SUMMARY

Ecosystem services are especially important for millions living in rural communities in developing countries. Many rural communities depend directly on a range of ecosystems services for their livelihoods and well-being and, due to isolation and a paucity of resources, may have few substitutes or alternatives to the services provided by ecosystems if they are lost or degraded. However, even where "rich" in ecosystem services many of these people remain mired in poverty with few opportunities to improve their wellbeing. Economic development is needed to improve their livelihoods. This has traditionally been achieved by significantly altering ecosystems to provide food and energy services. However, these changes can affect other ecosystem services, often resulting in unintended, negative consequences for those dependent on them. Hence, in the past, poor people have often paid the price of development. A key challenge for the water-energy-food nexus is to understand exactly how ecosystem services contribute to poverty reduction and how development can be achieved in ways that are sustainable and do not undermine vital ecosystem services. This session will comprise presentations from researchers contributing to the CGIAR Water Land and Ecosystems (WLE) program, which addresses this fundamental issue.

C03 Abstracts

1 Tracy Baker, Liza Debevec, Yenenesh Abebe, Beth Cullen

Biophysical scientists struggle integrating „gendered" water uses into models, with the latter necessarily based on physical laws describing water movement through the hydrological cycle. We typically assess watershed hydrological response to land management in terms of biophysical response. We may then loosely couple this to socio-economic variables. Results often present an incomplete picture of people's needs. Traditional methods used to describe socio-economic aspects of communities are not well-suited for inclusion directly into biophysical models. Scenario development supported by socio-economic data may be employed to account for agricultural productivity, land management, and water allocation within biophysical models. To address this, a simple methodology is being tested to incorporate gendered perceptions into biophysical assessments of water resources. A small watershed (Jeldu, Ethiopia) is used as a case study to generate gender differentiated three-dimensional landscape representations that are then georeferenced into ArcGIS. A spatial analysis and interpretation of men's versus women's identification and use of water resources is carried out, and the land use maps are used as the principal land use input for the Soil and Water Assessment Tool (SWAT).

2 Guillaume Lacombe, Somphasith Douangsavanh, Richard Vogel, Matthew McCartney, Yann Chemin

Increasing demographic pressure, economic development and resettlement policies in the Lower Mekong Basin induce greater population dependency on river flow to satisfy growing domestic and agricultural water demands. This dependency is particularly tight in upland areas where alternative water resources (groundwater) are scarce. As a result, communities tend to live closer to rivers, and so are more vulnerable to floods. This situation requires improved knowledge of flow variability for better management of water resources and risks. Unfortunately, stream flow measurements are scarce, especially in remote areas inhabited by the poorest and most vulnerable populations. Several water resource models have been developed to simulate and predict flows in the Lower Mekong Basin. However, most of these models have been designed to predict flow along the Mekong mainstream, precluding accurate assessments in headwater catchments. In most cases, their complexity and lack of transparency restricts potential users to modelling experts, and largely excludes those practitioners working closely with affected populations. The most integrated and informative way to characterize flow, at a specific location on a river, is to compute a flow duration curve which provides the percentage of time (duration) any particular flow is exceeded over a historical period. Using hydro-meteorological records from more than 60 gauged catchments in the Lower Mekong Basin, and a 90-meter digital elevation model, we used multiple linear regressions to develop power-law models predicting flow duration curves. These simple equations allow assessment of low, medium and high flow metrics, at any point on rivers in the Lower Mekong Basin, using easily determined geomorphological and climate characteristics. We believe that this parsimonious, transparent and highly predictive tool (89% <R2< 95%) can be used by a wide range of practitioners working in the fields of livelihood, water infrastructure engineering and agriculture. Acknowledgments: this analysis has been undertaken as part of the project „Natural and Built Infrastructures: ecosystems and flow" funded by the Water, Land and Ecosystems CGIAR research program.

3 Martin Volk

This presentation will describe key ecosystem services related to water and land resources and which ones can and which ones cannot be modeled with typically available river basin models such as SWAT. The panel will discuss applicability to the case studies presented during the session and identify incipient ecosystem service protocols for such modeling system.

4 Hua Xie, Gauthier Pitois, Claudia Ringler

Water quality is affected by emissions of pollutants from various socio-economic activities and has becomes a global problem. We present first set of results from our global water quality modeling study. The study focuses on assessing impact of socio-economic development and climate change on emissions of nitrogen of phosphorous from land systems to aquatic

environment. Notably, using currently available cropping pattern, fertilizer application, livestock density and climate data, we deployed a global model to estimate emission rates of nitrogen and phosphorus in base period (2000-2005) and under several designated socio-economic development and climate change scenarios. The study shows that the estimated annual emissions of nitrogen and phosphorus during the base period amount to 93 and 4 million tons/yr, respectively. By 2050, the global emissions of nitrogen are estimated to grow between 60-66%, and the global emissions of phosphorus are expected to increase by between 22 and 30%. These assessment results call for effort, which is supposed to be above the abatement level assumed in our study, to abate the negative impacts of socio-economic development and climate change on water environment.

photo © Martine Perret/UN

C04 Special Session: Nexus Implementation Pathways in River Basins – Political, Economic and Community Narratives for Action

SESSION CHAIR(S)
Henry Venema

ROOM
Salon Lenné

DATE
Monday, May 19
15:30 – 17:00

INSTITUTION
International Institute for Sustainable Development (IISD)

1 Arvind Kumar *(India Water Foundation, New Delhi, India)*
» Implementing the Nexus (of Water, Energy & Food Security) at the Trans-boundary Basin Management level in the Himalayan Region of South Asia: Challenges and Solutions

2 Anindita Sarkar *(Department of Geography, Miranda House, Delhi University, Delhi)*
» Water-Energy-Food Nexus In Punjab, India: Trends Turning Points and Alternative Solutions

3 Laura Woltersdorf *(Intitute for social-ecological research, Frankfurt, Germany)*
» Connecting water security, food supply and biogas production with small scale water reuse for urban agriculture in Namibia: Modeling water, nutrient and salt flows

4 Henry Venema *(International Institute for Sustainable Development, Winnipeg, Canada)*
» The Lake Winnipeg Bioeconomy Project: Pathways for Implementing Water, Energy and Food Security

SUMMARY

The concept of the W-E-F nexus is at once intuitive, complex and challenging for policy formulation and implementation. This session presents nexus case studies at various geographic scales with the intent of identifying common project narrative features that will compel policy and decision-making attention. The goal of the session is to assist researchers develop communication strategies for nexus projects that can command policy attention.

ABSTRACTS

1 Arvind Kumar

The paper looks at the nexus between water, energy, food security and climate change in the light of the consensus reached at Bonn 2011 Conference and the 2012 Rio+20 for finding sustainable solutions to the problems of poverty, inequitable distribution of resources, water scarcity, water and climate-induced problems frequently visiting the Himalayan region of South Asia, comprising Bangladesh, Bhutan, India and Nepal. This region assumes strategic importance since nearly one-sixth of global population inhabits this region and a sizeable proportion of that population is afflicted by poverty, malnutrition, lack of access to sanitation facilities, and acute shortage of drinking water. These issues are compounded by the possibility of conflicts over trans-boundary river water sharing and adverse impact of climate change.
The paper identifies the challenges in the implementation of the trans-boundary basin management. These include: lack of will on the part of political leadership; absence of confidence-building measures in cross-border areas to improve livelihoods of the affected people; negation

C04 Abstracts

of the role of the civil society; absence of regional media's role; lack of coordination in tackling water related issues; and reluctance to construct security community in South Asia through water cooperation.
It briefly examines the initiative for a Living Himalayas based on nexus approach undertaken by Bhutan in November 2011, which brought together Bangladesh, Bhutan, India and Nepal, as well as representatives of civil society. The summit agreed upon a regional ‚Framework of Cooperation' aimed at building regional resilience to the negative impacts of climate change in the Himalayas with the themes of ensuring food security and securing livelihoods; securing the natural freshwater systems in the region, ensuring sustainable use of biodiversity and energy security.
It further examines Meghalaya Model of nexus Approach. Meghalaya, located in the North-East region of India, has adopted the nexus approach as part of its Integrated Basin Development and Livelihoods Promotion Programme (IBDLP) launched in 2012. The IBDLP programme is designed around four pillars – Knowledge Management, Natural resource Management, Entrepreneurship Development and Good Governance and is being implemented in a mission mode through nine missions – Aquaculture Mission, Horticulture Mission, Livestock Mission, Sericulture Mission, Tourism Mission, Forestry and Plantation Crops Mission, Apiculture Mission, Energy Mission and Water Mission. Meghalaya can play a vital role in promoting cooperation with neighboring countries in transboundary basin management through implementing nexus.
The paper finally proposes a set of solutions through trans-boundary river basin management cooperation based on the nexus approach which can be used to enhance a broader set of benefits and opportunities that go beyond individual unilateral country level approaches.

2 Anindita Sarkar, Arijit Das

India's agricultural policy in the sixties primarily focused on self-sufficiency in food grain production. At this time a major technological revolution in the north western India ushered in the "grain revolution" through subsidized use of seed, fertilizer and irrigation. A policy of high procurement prices were also initiated to build up a buffer stock and a public distribution system catering to the food security needs of the country. Punjab, one of the first states and a major success of this technological innovation became the bread basket of the country. High yielding variety seeds also revolutionized irrigation from a risk reducing technology to a production augmenting technology bringing in the shift from canal irrigation to tubewell irrigation as it was a more reliable and flexible source of irrigation leading to a greater yield. Punjab's farmers gradually shifted to the most assured, remunerative as well as the most water intensive rice wheat cropping pattern. Being a semi-arid agro climatic zone, water intensive cropping pattern required wide scale extraction groundwater for irrigation. Gradually, electrification of pump-sets became an inevitable phenomenon which manifested in over pumping and lowering of the water table. Punjab started experiencing alarming signs of over-exploitation and also unprecedented electricity consumption. Agricultural electricity was made free which gave no price signal to resource depletion and also brought in financial burden to the exchequer. Today groundwater irrigation, food procurement policy and energy nexus has bound the farmers into a convenient yet a vicious relationship which although economically and ecologically unsustainable, there seems to be no way out. With this background in mind the paper analyses the trends and turning points of irrigation development and shifts in cropping pattern in Punjab; land and water productivity in Punjab's agriculture, energy-groundwater-food nexus in the state and finally the feasibility of cropping pattern shifts from water intensive rice-wheat cropping to less water intensive and hence less electricity consuming maize-wheat cropping in the groundwater over-exploited areas through direct transfer of agricultural electricity subsidy to farmers. It also reviews some of the new suggestions in the recent model groundwater bill which talks about incentives and sanctions against water-intensive crops.
The study would broadly focus on issues of interrelationships and interconnections of food production, water use in agriculture and electricity consumption which has direct bearing on the livelihoods of people dependent on agriculture, sustainability of agriculture and food security of the nation.

3 Laura Woltersdorf, Jörg Felmeden, Stefan Liehr, Müller Katharina

Water reuse and recovering nutrients for agricultural irrigation is a promising option to raise resource and energy efficiency.

C04 Abstracts

An innovative infrastructure is proposed by the CuveWaters project and consists of four connected parts: sanitation facilities, a vacuum sewer system, a wastewater treatment plant and an irrigation site. The infrastructure was introduced in a semi-arid region in central-northern Namibia in the town of Outapi. The nutrient rich water is reused for the irrigation and fertilization of an agricultural area planted with food crops. The wastewater treatment plant produces biogas by digesting sewage sludge and crop residues from the water reuse site and partly covers its own electricity and thermal energy demand. Pathogens and helminth eggs are eliminated to allow safe water reuse. The steady supply of nutrient rich water for irrigation and fertilization throughout the year means a high reliability for farmers and contrasts the seasonal and variable availability of natural water in the region. In addition, local food production and energy security for the operation of the wastewater treatment plant is increased. Revenues from crop sales help to subsidize drinking water and sanitation tariffs and contribute to the affordability of the operation of the infrastructure for the town and the local users. A methodology was developed to assess the environmental, energetic and economic sustainability of the proposed innovative concept. The methodology consists in calculating the pathogen reduction achieved with wastewater treatment including storage drip irrigation and crop choice, designing a crop scheme, modeling irrigation requirements, calculating nutrient requirements and salt tolerances of crops and quantifying water, nutrient and salt flows with mathematical material flow analysis. This methodology was applied for the the situations before and after implementation of the new infrastructure. First results showed that water productivity increases and crop requirements can be met. It was found that taking the behavior of facility users into consideration, less water and nutrients can be reused compared to assuming that all wastewater can be collected and reused for irrigation. The reuse water contains considerable quantities of nutrients that are sufficient to satisfy crop requirements, while the excess nutrients need to be controlled with adequate leaching and drainage. The salt concentration contained in the water originating from human excreta is suited for irrigation of food crops, the salt loads however are considerable and need to be collected in a drainage pond and disposed. The methodology allowed considering the behavioral impact of the facility users on water, nutrient and salt flows and their fate in the environment. The proposed infrastructure increases benefits for humans and nature and it could be shown under which conditions a win-win strategy for human development and environmental sustainability can be reached.

4 Henry Venema

The transboundary Lake Winnipeg Basin, shared by four Canadian provinces and four US states, is increasingly stressed by climate shocks such as flood and drought that reveal linked water, energy and food insecurities manifesting through the severe eutrophication of Lake Winnipeg – the most eutrophic large lake in the world. The basin exhibits the classic vulnerabilities of dryland agro-ecological systems worldwide that are subjected to hydrologic shock, land-use simplification and correlated nutrient over-loading.
Responses measures have largely focussed on conventional flood protection infrastructure and more stringent nutrient regulations, which overlook the potential co-benefits of a nexus approach. The award-winning Lake Winnipeg Bioeconomy Project, however uses an ecosystem-oriented nexus lens and builds the private investment case for distributed water storage, bioenergy production and carbon credits, while also creating public co-benefits such as climate adaptation, flood protection, drought resilience, water quality, habitat improvements and food security. The Lake Winnipeg case provides generalizable insights on how to develop "crisis-to-opportunity" narratives that builds the necessary political will and business interest for nexus implementation measures that address the root causes of vulnerability in the basin.
The general features of the Lake Winnipeg W-E-F case study include systems analysis of vulnerability and opportunity, regional ecosystem market development, business community outreach, mapping and indicator systems to guide project development, and the use of quasi-governmental agencies to promote transboundary collaboration.

C05 Tools to Address Synergies, Trade-offs and Resource Efficiency

SESSION CHAIR(S)
Rabi Mohtar,
Texas AM University

ROOM
Salon Haber

DATE
Monday, May 19
15:30 – 17:00

1 Joanne Vinke-de Kruijf *(Institute for Environmental Systems Research, University of Osnabrück, Osnabrück, Germany)*
» Trade-offs in freshwater management: what European regions can potentially learn from each other

2 Edward A Byers *(Newcastle University, Newcastle upon Tyne, UK)*
» A policy-oriented sensitivity analysis of cooling water consumption for low-carbon energy pathways

3 Johannes Halbe *(Institute of Environmental Systems Research)*
» Governance of Transitions towards Sustainable Development – The Water-Energy-Food Nexus in Cyprus

4 Dietrich Bartelt *(DB Sediments, Germany)*
» The Impact of Using Water – Why is Continuous Sediment Transfer in Reservoirs and Rivers so important for Sustainability in the Water-Energy-Food Nexus?

5 Anett Baum *(German Association for Water, Wastewater and Waste, Hennef, Germany)*
» Future-oriented technologies and concepts for an energy-efficient and resource-saving water management (ERWAS)

ABSTRACTS

1 Joanne Vinke-de Kruijf

The management and governance of freshwater has become an increasingly challenging endeavour in many countries. The international character and similarity of freshwater problems offers great opportunities for knowledge transfer. However, the effective transfer of policy aspects, programmes, institutions or ideas constitutes a challenge too. Actors of different countries may have difficulties to collaborate and to understand each other. Moreover, the solving of water problems often requires changes in governance structures. Such structures are hard to change and embedded in social and ecological systems, which imply that one cannot just copy solutions without modification. Using the experience of a Northwest European project, we reflect on the potential for European countries to learn from each other. The project addresses problems of water scarcity and drought, which were in Europe long seen primarily as a 'southern' problem. This perspective started to change in recent years. Even the water rich regions in Northwest Europe increasingly look for ways to mediate trade-offs between nature, agriculture, drinking water and other freshwater dependent sectors. Against this background, six regional water authorities and five knowledge institutes are currently implementing the project 'the benefit of governance in drought adaptation' (DROP). We examined the first round of bilateral exchanges between the participating water authorities to better understand what actors of different countries can learn from each other. The studied exchanges focus on three topics: trade-offs between freshwater for nature and agriculture (the Netherlands and England), freshwater management for agriculture (the Netherlands and Belgium), and the management of multi-use freshwater reservoirs (Germany and France). Actors identified interesting differences

C05 Abstracts

in terms of management (e.g. combining functions, modelling approaches and scale of solutions) and governance (division of tasks and rivalries). These differences challenged them to rethink their ways of managing and governing water resources. This learning process occurred both during incoming and outgoing visits. In addition, all actors identified specific topics on which their counterpart had more knowledge or experience. They anticipate to discuss these topics more in-depth during follow-up exchanges.
The exchanges in the DROP project show that most Northwest European regions are too different from one another to copy knowledge. Regions can nevertheless learn a great deal from each other, exactly because of their differences in terms of knowledge, experience, approach and governance. Exchanges on specific topics can be very instructive to experts. In addition, they inspire experts to rethink their ways of managing and governing water.

2 Edward A Byers, Jaime M Amezaga, Jim W Hall

Byers, E.A., Hall, J.W., & Amezaga, J.M. (2014) calculated water abstraction and consumption for the UK electricity sector and used this model to project future pathways of electricity sector water use in the UK to 2050. The 6 electricity pathways were derived primarily from the UK Government's Carbon Plan (2011) that explored the boundaries of possible energy futures for the UK. The pathways analysed were all low-carbon, yet had markedly different water use futures. Pathways with high levels of carbon capture and storage (CCS) result in in elevated freshwater consumption (37–107% over 2010), whilst pathways with high levels of nuclear power resulted in elevated tidal and sea water abstraction (148–399% over 2010). Pathways with high renewables and high nuclear result in the lowest levels of freshwater consumption. We show that up to 2030 good progress is made on both decarbonisation and water intensity, and that it is the capacity developed post-2030 that will determine whether pathways exploit the inertia of this progress or revert to water-intensive but low carbon generation.
Recently we have explored in detail the sensitivity analysis from the modelling work that tested assumptions around the cooling water sources and cooling methods for the pathways. In particular we investigate limiting the types of capacity on freshwater and higher uses of hybrid cooling. We align the alternatives tested with possible regulatory interventions and discuss how they could reduce freshwater consumption from the sector. Ultimately, we conclude that the electricity pathway is the dominant force of water use, yet is not something that can be determined. We suggest however the use of hybrid cooling or water-efficiency targets to keep at bay the sector's freshwater consumption and reduce the uncertainty around otherwise broad projections of electricity generation and freshwater use.
This presentation will showcase, for the first time publicly, methods and results used in the original paper, with discussion of the UK context and common implications for other countries. We then look in detail at the sensitivity analysis used to evaluate policy options in the paper submitted for the Summer Water Academy.
This work was supported by the Engineering & Physical Sciences Research Council, UK.

Reference:
Byers, E.A., Hall, J.W., & Amezaga, J.M. (2014). Electricity generation and cooling water use: UK pathways to 2050. Glob. Environ. Chang. Accepted. http://dx.doi.org/10.1016/j.gloenvcha.2014.01.005

3 Johannes Halbe, Claudia Pahl-Wostl

Water, energy and food supply is often managed in isolation without considering trade-offs and potential synergies. The water-energy-food nexus concept addresses this shortcoming but methods for the analysis of practical strategies to overcome lack of integration are still in their development phase. This paper presents a systems science methodology to analyze sustainability innovations in the water-energy-food nexus and strategies for governing transition processes towards their widespread implementation. Governance of transitions is understood as the process of fostering self-organized learning at different societal levels (i.e., the individual, community and policy level) to overcome barriers towards innovation. The methodology bases upon a participatory model building approach to analyze intersectoral effects and synergies of innovations which reside at a niche level today, but might become important elements of water, food, and energy supply systems in the future. Causal loop diagrams are developed by innovators, policy makers, and further stakeholders to reveal diverging system perspectives and further barriers towards effective cooperation and implementation of innovations. Learning requirements are determined and related to societal levels. Finally, a quantitative system dynamics model is developed (based upon causal loop diagrams from the interviews) for an integrated assessment of innovations from a nexus perspective (e.g., determine intersectoral side-effects).
The methodology is applied in a case study in Cyprus to analyze sustainability innovations that address the national issues of water scarcity and fossil fuel dependence. The need for a nexus perspective is particularly obvious in Cyprus, due to high water consumption in the agriculture sector and application of energy-intensive seawater desalination for potable water supply. Innovative approaches in the energy, water and food systems are analyzed in this case study, such as solar-powered desalination plants and organic agriculture. The results show that more sustainable alternatives are already existing, but are retained by several socio-economic aspects, such as consumer habits or hindering legislation. In addition, stakeholders in Cyprus have differing visions for sustainable development which also hamper effective cooperation and implementation. Sustainability visions range from low-tech, decentralized to high-tech, centralized solutions for water, food and energy supply. Instead of determining optimal solutions, the results suggest that a co-existence of decentralized and centralized solutions tailored to local contexts (e.g., urban/rural contexts) is a promising approach to utilize synergies from the nexus approach.
Finally, arguments will be provided for a global innovation platform to facilitate exchange across regions. Effective knowledge exchange requires an assessment of comparability and thus a systematic methodology as presented in this paper.

4 Dietrich Bartelt, Christian Jokiel

Almost every reservoir is affected by sedimentation. The World Commission on Dams estimated that each year almost 1 % of worldwide storage capacity is lost due to this effect - a global challenge with regard to reservoir engineering. Dredging and disposing reservoir sediment is extremely expensive. On the other hand stored or extracted sediment which is missing downstream of reservoirs leads to erosion damages, substrate deficits and ground water problems. But also inaction worsens the situation concerning: storage capacity for water, decreasing the retention volume for flood protection and increasing the production of methane and therefore negatively influence the climate change.

When removing the sediments or even reducing the sediment volume in reservoirs for hydropower generation or for the storage of water for drinking water or irrigation, the facilities plant operators are faced with exorbitant costs; we talk several million Euro range even for small reservoirs. Moreover, the various sediment removal procedures applied so far – flushing through the main valve, manual or sludge dredging – all have various additional negative secondary effects ranging from compromising the operation (up to plant shut down for several months), loss of huge quantities of water to negative morphological or ecological impacts. Furthermore continuous sediment transfer can have positive effects with respect to the characteristics of wave dynamics.

Within this paper we will present an innovative technical approach which makes reservoirs penetrable for sediment avoiding above mentioned secondary effects. Incoming as well as already settled sediment is continuously transferred through the reservoir and fed over long time spans in morphologically and ecologically compatible concentrations downstream by applying newly developed equipment. Reservoir management is not affected and the approach is performed during daily reservoir operation. It is applicable to almost any range of plants, small to large and run-of-river to pump storage, for drinking water and irrigation water reservoirs. This approach does not only restores the overall sedimentation process to a near to natural state but also fulfills the requirements of the Water Framework Directive 2000/60 of the European Community as well as the US Sediment Acts. Moreover, as the equipment is fully automated, it is also economically very competitive, even without considering the avoided costs of the secondary effects. We like to mention that this invention has received the PLATTS-Award "Leading Global Sustainable Technology-Innovation of the Year 2011", was nominated for the Zayed Future Energy Prize, and furthermore has received the Initiative Prize for renewable energies and environment in the state of North-Rhine Westfalia in Germany.
Within the paper we will give details about the technical approach as well as how the river ecosystem can be improved and the

C05 Abstracts

impact of using water can be balanced. Furthermore the projects economics and results gained so far will be presented as well as the advantages from point of view of the operator. Ecological benefits have already been proven in numbers by an accompanying monitoring program.

5 Anett Baum

Background

Water is an irreplaceable resource for mankind. The supply of water in sufficient quantity and quality as well as safe waste water disposal are among the most basic human needs.

However, the management of this resource – from the supply of drinking water to waste water treatment – requires significant amounts of energy: the existing installations in Germany for public water supply and waste water treatment together consume 6.6 TWh per year of electrical energy, which is equivalent to the annual electricity needs of about 1,600,000 four-person households.

At 4.2 TWh per year, the sewage treatment plants are the largest consumers of electricity in the municipal sector and have higher power requirements than, for example, schools or street lighting. Through energysaving measures and increased efficiency there is, however, an estimated savings potential of up to 25% of this power consumption.

In order to realise the above-mentioned savings potential and the production of energy from water management plants, innovative approaches are needed. This is where the funding programme "Future-oriented Technologies and Concepts for an Energy-efficient and Resource-saving Water Management" – ERWAS comes into play.

The funding programme is part of the Federal Ministry of Education and Research (BMBF) funding priority "Nachhaltiges Wassermanagement – NaWaM" (Sustainable Water Management) in which the BMBF focuses its activities on the field of water research within the framework programme "Forschung für nachhaltige Entwicklungen" (FONA) (Research for Sustainable Development).

Objectives of the funding measure

Based on practical concepts and technologies, a contribution is to be made to the development of sustainable, energy-efficient water supply and waste water disposal. The focus here is on improving the energy balance and on resource-saving energy generation. In the case of waste water treatment, energy autonomy or even an "energy positive" supply situation could be achieved through innovative approaches. Furthermore, it is to be investigated how water management plants can be intelligently integrated into the water and energy infrastructure of the future.

Contents

Within the framework of the funding measure, the BMBF supports 12 joint research projects with partners from science, industry and practice.
A major focus of the funded projects is on the development of new concepts of interaction between the drinking water, wastewater and energy sectors. Examples include the use of the load management potential and the energy storage capabilities of the water sector for the future energy systems. Here, among other things, research is carried out into how water management facilities can play a balancing role as an energy source or sink given stronger fluctuations in the electricity supply from renewable sources (wind and solar power) in future.

Furthermore, innovative methods of energy production and energy conversion at water management facilities are to be developed, such as the optimised power generation in microbial fuel cells or conversion to methanol. The focus is also on finding new ways to improve realisation of the energy potentials in the sewage sludge with simultaneous utilisation of the resources contained in waste water, such as phosphorus.

In several collaborative projects, the use of the energy potential in water supply plants is in the foreground. One thematic focus here is in the area of process optimisation.

For further information: www.bmbf.nawam-erwas.de ■

C06 Approaches to Resource Management for the Nexus

SESSION CHAIR(S)
Hong Yang,
Global Water System Project (GWSP)

ROOM
Salon Hauptmann

DATE
Monday, May 19
15:30 – 17:00

1 Anthony P. Hurford *(HR Wallingford, Wallingford, United Kingdom)*
» Balancing the Benefits from Water Management Decisions by Visualising Pareto-Optimal Trade-Offs

2 Birgitta Putzenlechner *(Ludwig-Maximilians University, Munich, Germany)*
» Global Agricultural Potentials - Ecological and Economic Considerations

3 Lucie Pluschke *(Land and Water Division of the Food and Agriculture Organization of the United Nations, Rome, Italy)*
» FAO`s Nexus Approach

4 Golam Rasul *(International Centre for Integrated Mountain Development, Kathmandu, Nepal)*
» Understanding the Water Energy Food Nexus from a Mountain Perspective

ABSTRACTS

1 Anthony P. Hurford, Julien J. Harou

Trade-offs are unavoidable in many decisions and can be accounted for in water resources management through cost benefit analysis (CBA) which needs commensurate units, usually monetary. Monetary valuation of non-market ecosystem good and services remains challenging, sometimes undermining effectiveness of CBA in ensuring sustainability of environmental resource use. Multi-criteria search algorithms are available which identify Pareto-optimal trade-offs between up to 10 management objectives without the need to harmonise or monetise units of measurement. Market and non-market benefits can be traded off against each other. We couple such an algorithm to a river basin model to define trade-off curves and surfaces between a broad range of stakeholder interests (objectives) in management of the basin's water resources. Stakeholders include hydropower generators, irrigated farmers, water supply companies, riparian farmers and fishers and sensitive ecological sites. By iteratively evaluating the different objectives the search algorithm manipulates multi-reservoir system operating rules to identify the Pareto-optimal set of benefits and the rules which achieve them. Results are presented as 3D Visual Analytic plots to help decision-makers appreciate the full range of 'best case' options they face and understand the environmental and social impacts of each. Case studies from Brazil and Kenya are used to demonstrate how the approach can be used to identify win-win opportunities and balance investments in economically productive activity with support of rural livelihoods.

2 Birgitta Putzenlechner, Florian Zabel, Wolfram Mauser, Ruth Delzeit, Gernot Klepper

Recent studies estimate that a growing world population, increasing incomes and changing diets will likely increase the demand for food, feed, fuels and fiber and similarly for water by 70-110% by 2050. There is also general concern that agricultural yields are threatened by climate change, particularly in countries of the Global South. Ensuring food security

C06 Abstracts

under a doubling demand and assuming that intensification of agricultural production will rather take place than expansion of agricultural land opens up the question whether the demanded agricultural commodities can be produced in a sustainable way with the globally available natural resources. Agro-ecologic yield gaps as ratios between what can potentially be harvested and what is actually harvested on existing fields are usually determined to answer this question. Latest studies on global potentials assume the current spatial allocation of crops on arable land under current environmental conditions. They agree on an estimated global agro-ecological yield gap in the range of between 1.5 to 1.6. This suggests that even a complete mobilization of the estimated potentials would be insufficient to satisfy future biomass demands.
We present a new approach to estimate global crop distribution and biomass production potentials. It allows the total area of currently cultivated land to spatially re-allocate and recognizes the importance of economic factors on agricultural potentials by coupling a high resolution bio-physical crop growth model with an economic general equilibrium model. During coupling we maximize farm-profit of potential yields which leads to the most profitable spatial re-allocation of the cultivated crops. This procedure results in a global agro-economic yield gap which increases from 1.5 to 2.6. This means that today's agricultural production could theoretically be increased by 160% without the expansion of agricultural land and changes in current absolute extent of cropland by planting crops where they produce the largest farm-profit (excluding IUCN protected areas and dense forests). Thus, our study calls for a revision of estimated global production reserves. It also suggests that, although the yield gaps will not completely be closed by 2050, the re-allocation of crops with regards to both natural and economic constrains leaves scope for a thorough discussion of alternative sustainable future agricultural production options, including both ecological intensification and extensification.

3 Lucie Pluschke

Given its mandate of achieving food security, FAO will highlight the importance of food and agriculture in the nexus. Food security alone is not an indication of economic, social and environmental sustainability. Underlying the nexus is a holistic vision of sustainability that tries to balance different development goals by managing trade-offs between different resources.
FAO will present its concept note and experiences in developing an approach to assess and manage the water-energy-food nexus uses across sectors and scales

4 Golam Rasul, David Molden, Aditi Mukherji, Arun Shrestha, Ramesh Vaidya, Shahriar M. Wahid, Philippus Wester

There is a distinct spatial dimension to the W-E-F nexus. For example, in upstream mountain regions, use of water for producing energy is the driving force, with food production taking a backseat. It is therefore important to develop nexus perspective keeping different spatial scales in mind.
From a mountain perspective, there are at least three different, yet interrelated ramifications of this nexus.
First issue is that of upstream-downstream linkages within a river basin context. Mountains, as water towers, are the source of water which then flows downstream and is used for various purposes, the most important of which is for food production. Given scarcity of land and uneven and often inhospitable terrain in the mountains, mountains cannot grow enough food to meet its needs and sources its food from the plains. The plains derive energy security from the hydro-electricity that is generated in mountain areas. This energy is used for various purposes, including for pumping groundwater to grow crops. The key issue here is: how do we ensure that mountain communities are able to derive benefits from the services that they provide to downstream users? This calls for an integrated river basins approach where nexus principles have been internalized by all key decision makers.
Second issue is that of seasonality of water and energy demand. How does one meet the energy needs, of say, dry season irrigation in plains, at a time when river water levels are running low? The obvious answer is hydropower dams. While such dams are indeed needed, the inherent fragility of mountain ecosystems makes them environmentally problematic. Here again, the nexus approach provides a less obvious, but equally appealing solution. The transition zone between mountains and plains happens to be an active recharge zone for groundwater. In the plains just below this transition zone there is a large unmet irrigation demand in summer season – a demand that is unmet even though groundwater is available in plenty. This is due to lack of access to affordable energy. Electricity produced through hydropower schemes upstream can be used to exploit and bring down groundwater levels in the summer season and then, aquifer storage so created, can be effectively recharged using monsoon flow. Again, this requires an integrated approach where surface and groundwater are co-managed.
Finally, there is the issue of water, food and energy security at a local scale in the mountain regions. This calls for local solutions. Solar pumps are increasingly used in the mountains to transport water up from streams to the settlements, which are often located in the ridges, for household uses. Furthermore, there are examples of dedicated small hydropower plants being used to generate electricity locally to pump up surface water from rivers to irrigate farms in the flat lands, or tar, in the mountains.
■

C06 Abstracts

Finally, there is the issue of water, food and energy security at a local scale in the mountain regions. This calls for local solutions. Solar pumps are increasingly used in the mountains to transport water up from streams to the settlements, which are often located in the ridges, for household uses. Furthermore, there are examples of dedicated small hydropower plants being used to generate electricity locally to pump up surface water from rivers to irrigate farms in the flat lands, or tar, in the mountains.
To sum up, mountain systems play a significant role in downstream agriculture and food security. The global community must look to mountains to resolve issues of energy, water and food security, and to help people cope. To date, the conservation efforts of mountain people remain unrewarded, yet the benefits are for all of us. Institutional mechanisms need to be established and strengthened to secure the payment and reward mechanisms for mountain ecosystems services including surface and ground water, water storage and others relating to energy and food security. What happens to mountains is of global concern – whether or not there will be enough food and energy for all will depend in part on what happens in

photo © Evan Schneider/UN

D01 Implementing the Nexus at Various Scales: Connecting Metropolitan Regions and their Environment

SESSION CHAIR(S)
Luis Veiga da Cunha,
Calouste Gulbenkian
Foundation

ROOM
Salon Hauptmann

DATE
Tuesday, May 20
11:00 – 12:30

1 Adrian Atkinson *(New Synergies in Development, Geneva, Switzerland)*
» NEXUS Initiatives to Improve Resource Management amongst the Urban Poor

2 Kathrine Brekke *(ICLEI-Local Governments for Sustainability, ICLEI World Secretariat, Bonn, Germany)*
» The Urban Nexus – operationalizing nexus opportunities in cities and metropolitan regions

3 Francisco Meza *(Centro de Cambio Global, Santiago, Chile)*
» Addressing Global Change Challenges in Central Chile through the lens of Water Food Energy Nexus

ABSTRACTS

1 Adrian Atkinson

In the past, availability of cheap and abundant fossil energy encouraged wasteful resource use in urban infrastructure development and operation in northern cities. Emulated in southern cities, this was always beyond the means of urban authorities and populations and, with the threat of rising energy prices, new approaches have urgently to be found. Salient problems have been: water supply dependent on pumping and (poorly-built and maintained) treatment and reticulation; sanitation that required substantial financial resources and problems of 'waste disposal' – that was never effective in the vast majority of southern cities; and food delivered from increasing distance, with accompanying growth in energy costs to produce and transport.
Significant reduction in costs of urban resource supply from renewable sources can be made inter alia through city-wide rainwater harvesting and re-use of grey water to satisfy local water needs. Ecosan should also be applied city-wide, to recover human waste, with biogas digestion supplying energy locally. The resulting sludge, together with composted urban organic solid waste, can then be used for soil improvement, applied to intensive urban and peri-urban agriculture (UPA) to increase food security.
All of these, however, need to be connected into coherent (nexus) systems, appropriate to particular conditions in each city, requiring institutional change and effective support. Close community involvement and cooperation as well as significant cultural change are prerequisites, particularly to avoid health hazards arising from poor management. If successful, such systems can be profitable – and generate local employment - where existing urban resource management systems are nothing but a financial drain on urban authorities and communities.
The last part of the paper will discuss pending GIZ initiatives in Asia and in the context of the Sustainable Development

D01 Abstracts

of Metropolitan Regions programme in African and Asian cities.

2 Jeb Brugmann, Kathrine Brekke

Complex Growing Cities and Growing Costs: Cities and metropolitan regions consume over two-thirds of the world's energy, and require multiple resources to sustain the functions and services necessary for vibrant, productive and sustainable communities. These vast flows of inputs and outputs such as materials, water, food and energy permeate city boundaries in complex systems. In an effort to control and manage the complexity of the numerous interconnected systems that constitute our cities - technical, built, and infrastructural systems; as well as social, political, economic, and ecological systems - modern urbanism divided and dis-integrated cities into component parts: jurisdictions, departments, single purpose zones, services silos, legal categories, and technical disciplines. This has resulted in inefficiencies, lost opportunities, and problems of dis-integrated approaches to urban development that continue to dominate our urbanizing world today.

The Urban Nexus - Seeking opportunities and efficiency in service delivery solutions: To create efficiencies in urban systems by drawing upon their inherent interconnectedness, the Urban Nexus is a project design approach that focuses on identifying real-world points of integration and developing opportunities to achieve multiple urban policy objectives through single investments, projects, or programs. This is achieved by re-integrating activities, services, functions and built systems and by coordinating activities across departments and scales, in order to achieve results at different levels: Physical resource re-integration, service/facility re-integration, institutional re-integration, and behavioural re-integration when providing various urban, educational, and social services.
The study offers an Urban Nexus project cycle as a step-by-step guide from the first identification and assessment of the nexus opportunity, to designing, implementing and up-scaling the developed solution.
The Urban Nexus aims to realize synergies and resource gains by linking sectors in innovative ways – for example linking urban transport to waste management schemes, and in this respect goes beyond the traditional water-energy-food nexus.
Case studies: A compilation of case examples, including select in depth case studies, gives empirical evidence of the benefits of re-integrating the city, place by place, system by system.
ICLEI and GIZ propose a session to present the key findings of this study on the Urban Nexus, as well as illustrative case studies and experiences from 2 pilot projects in India and Tanzania that are part of the same BMZ-funded project, and to discuss how the potential of an inter-sectoral Urban Nexus is shown and translated in cities.

3 Francisco Meza

Central Chile faces important challenges associated to Global Chnage. Decreasing water availability in river basins, rising temperatures, increased probabilities of drought occurrence, and increasing water demand can result in future water crisis. Agriculture, Major cities and Hydropower generation are the most important water users that can be severely affected by these changes.
Sustainable water management practices and policies, as well as innovative research that supports decision-making are required to effectively answer to these challenges.
In the mediterranean and semi-arid regions of Central Chile, we find interesting examples of such systems.
The Centro de Cambio Global has established long lasting relationships with relevant stakeholders in key relavant basins and develop science/policy dialogues to increase the ability to cope with global change scenarios
In this work we present the relevant dilemas through the lens of Water Food Energy nexus as being identified by scientits, policy makers and stakeholders.


photo © UN photos

D02 Special Session: Sustainability in the Water-Energy-Food Nexus - An Environmental Resources Perspective

SESSION CHAIR(S)
Reza Ardakanian

ROOM
Salon Arndt

DATE
Tuesday, May 20
11:00 – 12:30

INSTITUTION
United Nations University
Institute for Integrated
Management of Material
Fluxes and of Resources
(UNU FLORES)

1 Mathew Kurian *(UNU FLORES, Dresden, Germany)*
» Institutional Arrangements: Co-Provision as a Nexus Concept

2 Stephan Hülsmann *(UNU FLORES, Dresden, Germany)*
» Nexus in practice – a systems analysis approach

3 Mari Ito *(UNU FLORES, Dresden, Germany)*
» Water resources management from a Nexus perspective, a case study in Africa

4 Kai Schwaerzel *(UNU FLORES, Dresden, Germany)*
» Neglecting the Soil-Water Nexus hampers the sustainable regional development in NW China

5 Hiroshan Hettiarachchi *(UNU FLORES, Dresden, Germany)*
» Open Dumps to Nexus approach: Historical evolution of waste management

SUMMARY

In many regions of the world, food security and water security is at risk due to the overuse of water resources and soil degradation. Climate change will further exacerbate these risks, particularly in water-limited environments and in marginal regions. The unprecedented population growth will further increase the demand for food, feed, fiber, and wood.
At the same time, the accelerated urbanization will not only reduce the amount of land available for biomass production but also increase the risk of soil degradation through waste disposal and air pollution. These examples clarify that the resources water, soil and waste are intertwined. Fixing one problem in one resource often creates new problems in other resources. A more sustainable solution may be achieved if these resources are managed in combination using a nexus approach. UNU-FLORES advances a nexus approach to the sustainable management of water, soil and waste. The institute was established in December 2012 in Dresden, Germany. In the intended session, it will be shown that the analysis of material fluxes and resource inventory (quantity and quality) is a prerequisite for their sustainable management, and that individual and institutional capacities are needed for environmental governance. Finally, examples of the interconnected management of the environmental resources water, soil and waste will be presented and discussed, as bases for the development and management of water, food and energy.

D02 Abstracts

1 Mathew Kurian

Irrigation is crucial to improving agricultural productivity, sustaining rural livelihoods and promoting economic growth. Governments have invested in developing irrigation infrastructure in Asia, Africa and South America. However, the gap between Irrigation Potential Created (IPC) and Irrigation Potential Utilized (IPU) has continued to grow. The nexus approach to management of water, soil and waste resources emphasizes the need to understand: (a) scope for trade-offs, (b) scope for synergies and (c) analytical methods that capture resource optimization that arises from management of trade-offs and synergies. Recent studies that elaborate upon elements of such a framework refer to co-provision as a key concept. Co-provision is essentially a concept that emphasizes the importance of understanding the following processes (Kurian and Dietz, 2013, Kurian and McCarney, 2010):

» Hierarchical social relations that offer opportunities for local leadership to emerge to effectively enforce irrigation management rules
» Exercise of discretion by public officials in enforcement of rules at different levels of government
» Uncertainty in factor and product markets that influence incentives for cooperation
» Risks posed by variability in climatic, soil and groundwater conditions that influence irrigation system performance
» Accountability in fiscal relations between different levels of government that influences decisions on infrastructure design and incentives for undertaking maintenance

2 Stephan Hülsmann

The water, energy and food security nexus is increasingly recognized as valuable approach towards sustainability and ultimately towards a green economy by reducing trade-offs and building synergies across sectors. When asking which environmental resources need to be managed in an integrative way for making the water-energy-food security nexus operational, it turns (mainly) into a water, soil and waste nexus. The production of food relies on water and soil, with waste being an important factor for the provision of nutrients and organic material. The same is true for the production of biofuel and energy from biomass. Additional links to energy exist for water (hydro power, conversion from heat to energy, cooling water) and waste (biogas, thermal energy from waste). Instead of following a traditional input-output model, a nexus approach to resources management requires the consistent tracing and management of resources as fluxes. This implies to apply systems analysis approaches to the analysis of material fluxes and resource inventory (quantity and quality), to perform scenario analyses to forecast material fluxes under conditions of global change and to develop, modify and apply modelling tools to perform such analyses. While closing cycles, quantifying fluxes and considering scales is an issue in every modelling approach for resources management, a particular challenge of “nexus modelling” is to link cycles of related resources. Integrated reservoir management is proposed as one potential practical application of putting the nexus approach to the management of water, soil and waste into practice.

3 Mari Ito

Water, food and energy are related to basic needs for sustaining human life. The term, the nexus of water, food and energy security, is relatively new, but the inter-connection of water, food and energy systems has been found along the human history and across countries. From a resource perspective, environmental resources, water, soil and waste are interconnected and are related to the entire or a part of water-food-energy nexus, including water-food, water-energy and water-energy nexus. In the presentation, a water resources issue in Africa will be looked into where the water resources issue is actually closely related to food and energy security and is affected by challenging climate conditions, suggesting a need for integrated approaches to environmental resources.

4 Kai Schwaerzel

The Loess Plateau is among the most erosion-prone areas of the world, where erosion rates of up to 30,000 t km2 yr-1 have been observed. To control soil erosion on the plateau, large-scale vegetation restoration projects (mainly afforestation) as well as the building of slope terraces and check dams have been implemented over the past six decades. These measures have been effective in the control of soil erosion, but have been accompanied by a drastic reduction in water yields from the main tributaries of the Yellow River. This has led to an emerging debate about forest development, since there is growing concern that improper affores-

D02 Abstracts

tation practices will increase water use conflicts and, as a result, may impede sustainable development in the region. It will be shown that the effect of land use changes on annual stream flow attenuates with increasing size of the catchments. This means that, the implementation of ecosystem restoration measures requires careful consideration of several factors, including both the onsite changes in local soil retention and the off-site effect on stream flow, especially in area with water shortage. It will be discussed what kind of vegetation management may help to control soil erosion and to increase the water yield.

5 Hiroshan Hettiarachchi

Waste management has a history which is as old as the history of human civilizations. As a society we have come a long distance from open dumping, which is still practiced in some parts of the world, to more modern and advanced waste management tools. Integrated solid waste management (ISWM) became a popular term few decades ago, and to a certain extent, ISWM also helped the society to understand the value of "waste." But focusing only on waste and addressing waste-related issues without paying any attention to the other closely related environmental resources, is far from ideal. Water and soil are the two naturally occurring environmental resources that are closely related to and/or affected by the management methods of waste. Within this context, this presentation is focused on how a nexus approach may be more helpful to resolve the issues in waste management together with resolving the issues in the management of water and soil/land use. First half of the presentation will provide an overall introduction to waste as an issue and also the historical evolution of waste management. The latter part of the presentation will discuss the importance of the nexus approach in waste management together with examples. The role of UNU-FLORES in integration management of water, soil, and waste is also briefly discussed at the end.

D03 Special Session:
Co-Optimizing Solutions for Water and Food – Scoping the Nexus Challenges in the Agro-Sector and Finding Scalable Business Solutions

SESSION CHAIR(S)
Joppe Cramwinckel

ROOM
Saal Reger

DATE
Tuesday, May 20
11:00 – 12:30

INSTITUTION
World Business Council for Sustainable Development (WBCSD)

1 Alexander Müller *(Senior Research Fellow, Institute for Advanced Sustainability Studies, Potsdam, Germany)*
» Water, Food and Energy Nexus Challenges

2 Edeltraud Günther *(Chair of Environmental management, TU Dresden, Germany)*
» Co-optimizing economic and ecological goals – how can companies contribute to the Nexus challenge

3 Ankit Patel *(Resourcematics Ltd, London, UK) (*on video chat)
» The Nexus Model

4 Frank van Steenbergen *(MetaMeta, the Netherlands)*
» Focus on key co-optimising solutions

5 Liese Dallbauman (Water Stewardship Director PepsiCo)
» Case studies and lessons learned when sourcing products with a nexus approach

SUMMARY

The session will provide an overview of the main challenges and impacts associated with increasing demand for agricultural products – not only crops but also fodder and fiber – as a result of population growth and changing consumption patterns.

ABSTRACTS

1 Alexander Müller

The coming years will see major challenges in sustainably meeting the increasing demand for food, fiber and fodder. The presentation will provide an overview of the main challenges and impacts associated with increasing demand for agricultural products as a result of population growth and changing consumption patterns.

2 Edeltraud Günther

Managing natural resources is one of the key challenges for companies and has been one of the core issues of sustainability research and practice for decades. The presentation will elaborate on the question whether it pays to be sustainable and present the results of four decades of research on the link between corporate environmental performance and corporate financial performance, and more specifically the results of empirical studies on resource and water efficiency. In order to support companies in better understanding both the environmental and financial consequences of their material and energy use, the International Organization for Standardization has developed a standard on Material Flow Cost Accounting (MFCA), released in September 2011: a powerful tool for management.

D03 Abstracts

3 Ankit Patel

The nexus model develops an integrated scenario to enhance business understanding of the global linkages through a quantitative analysis of (i) water demand for energy, (ii) water demand for food, (iii) energy demand for water (only agriculture water excluding industrial and domestic water) and (iv) energy demand for food production. Geographically the model offers a wide spectrum of information from global to as small as a square of 25 km (approximately 5X5 km grid). In particular, it provides answers to the following questions:
- What are the constraints on the availability of water and energy resources as a result of future food/feed/fiber/fuel/biomaterials demand?
- Which crops and geographies of interest can be considered hotspots today and in 2030, 2050 and why?
Some of the insights it offers force to revisit prevailing theories and rethink policies. For instance higher water efficiency may not necessarily mean an energy efficient proposition and hence, the model guides towards co-optimization of resources. With new and updated data (e.g. latest crop data, energy use for water treatment) the model will increasingly offer more realistic scenario encompassing energy demand for domestic and industrial water.

4 Frank van Steenbergen

Overview of smart and scalable solutions for increasing agriculture production with less energy and water - missing or unused knowledge and techniques, new applications for small farmers and supply chain contribution, sustainable landscaping… Solution areas capture a large part of the options at hand to address the co-optimization challenges – balancing the inevitable demand for food, fodder and fiber, yet remaining within the limits of water and energy availability at minimum or zero environmental impact. Broad categories as better blue water management, better green water management, bridging the yield gap or reducing waste hide a myriad of more specific innovations. Moreover, many solutions are integrated, thus enabling, reinforcing or multiplying each other.

D04 Governance and Management of the Nexus: Structures and Institutional Capacities

SESSION CHAIR(S)
Christoph Görg,
Helmholtz Centre for
Environmental Research
(UFZ)

ROOM
Salon Rheinaue

DATE
Tuesday, May 20
11:00 – 12:30

1 Kathrin Knüppe *(Institute of Environmental Systems Research-University of Osnabrück, Osnabrück, Germany)*
» The relevance of nexus thinking towards adaptive and integrated resources management

2 Beatriz Medina *(Amphos 21, Barcelona, Spain)*
» Communicating Water Science across the 'Nexus': the European WaterDiss2.0 Project

3 Glada Lahn *(Chatham House, Royal Institute of International Affairs, London, United Kingdom)*
» Valuing Vital Resources: International lessons learned in pricing energy, water and food to incentivize sustainable consumption

4 Christian Stein *(Stockholm Environment Institute, Berlin, Germany)*
» The role of social networks for governing the nexus

ABSTRACTS

1 Kathrin Knüppe

Water security is closely linked to food and energy security. Due to diverse interests between human and environmental needs trade-offs are likely to occur between the three securities. 'A water-food-energy nexus thinking' is therefore critical for ensuring that sustainable economic growth, human security, political stability, and environmental health can be achieved jointly. Worldwide, most resources management systems do not allow for implementing the nexus thinking into day-to-day decisions. Therefore, adaptive and integrated management approaches are required to integrate the nexus thinking both at higher policy levels and at the implementation level. In this context, the following management dynamics are assumed to play a crucial role: (i) institutions (formal and informal settings), (ii) actor networks (role and patterns of interactions of state and none-state actors and power relationships), and (iii) multi-level structures (cooperation between different administrative levels). To understand how these management dynamics govern and regulate trade-offs between human and environmental water securities a system-science approach was chosen to untangle this complexity. The analytical approach was supported by the Management and Transition Framework (MTF) and a relational database (RD). The MTF and the RD enable to determine change within management and policy processes (e.g. the role of nexus thinking, dealing with trade-offs) over a certain period of time across different case studies. This in turn is desirable to have comparable time series of data that allow determining trends of adaptive and integrated management. Research conducted on the Spree River in Germany and the Sandveld Region in South Africa highlight the importance of nexus thinking towards adaptive and integrated management. Both cases are characterized by trade-offs between freshwater requirements for irrigation purposes, mining activities, municipality supply, tourism, and nature conservation. The main research questions are: how did management dynamics change over time in favor of nexus thinking and what are the main impacts on ecosystem services and human well-being? Results indicate that both cases are characterized by certain management practices (especially at the local level) that are supportive of

D04 Abstracts

an integrated perspective of water, food and energy (=nexus thinking). However, successful implementation of a nexus approach in formal management processes is constrained by a lack of sectoral and administrative cooperation, inflexibility and mistrust between different actors. The paper ends with some critical reflections on the challenges of implementing the nexus thinking both at higher and lower levels of management.

2 Beatriz Medina, Ulf Stein, Evelyn Lukat, Carolyn Roberts, Michal Sedlacko, Alex Bielak

The European Water Framework Directive (WFD; 2000/60/CE) laid down challenging objectives for water bodies, the achievement of which requires public involvement and harmonised dissemination of research findings across Member States. At a time when water resources are facing unprecedented pressure from climate change, demand is rising and environmental legislation is tightening, recognition of the water-food-energy nexus offers the enticing prospect of beneficial cross-sector policy integration, provided that different sectors can talk to each other. Common water knowledge needs have been apparent for over a decade, but until now the typical length of time needed to complete the development cycle from research to application is ten years; research commissioned today would only impact management practices in 2025, well after the WFD's 2015 and 2021 milestones. Moreover, shortcomings in the uptake of knowledge mean that much commissioned research is never used by policy-makers. Despite the existence of published guidelines for dissemination of scientific findings, the current gap between research and policy suggests an overarching need for new skills in facilitation to maximise connections, support exchange of knowledge, develop understanding, and exploit synergies.
The science-policy interface is a complex dynamic system where interactions at different levels take place, allowing for exchanges, co-evolution and joint construction of knowledge, thus enriching decision making. Knowledge is never static and changes with every context. The WaterDiss2.0 project worked with many recipients of EU funding, analysing their communication approaches and identifying strategies for effective and speedy transfer of water-related research results to likely users in the water, food and energy sectors. It was recognised at an early stage that knowledge brokerage is a multi-directional learning process rather than one-way distribution: 'exchange', rather than 'transfer', with the aim of mutual improvement. Observations and insights ultimately led to the formulation of recommendations for researchers, policy makers, research funding organisations and science communication experts, presented in this paper.
The first set of recommendations aims to improve the content of funding calls and programmes, as well as the process of writing bids for resources. The second set concerns dissemination undertaken during individual research projects, such as the use of social media, publications, presentations and meetings. The final set relates to the period after completion of a project, when outputs are ready to be used. There is considerable evidence that the tools developed through the WaterDiss2.0 project are usable across disciplines, and beyond the EU.

Acknowledgement:
The work leading to this publication has received funding from the EU FP7 ENV.2010 5.5.0-1 grant agreement n°265167

3 Glada Lahn, Rob Bailey, Paul Stevens

This paper will present key findings and recommendations from a year-long multi-stakeholder project coordinated by Chatham House (The Royal Institute of International Affairs in London) to create an expert dialogue on the costs involved in water, energy and food production and how these might be best reflected in pricing strategies. It will draw on the forthcoming report, Valuing Vital Resources (due May 2014), which focuses on the Arab Gulf but brings to light a wealth of international insight and experience in attempting to assess and reflect resource values in strategies to incentivize sustainable consumption.
The nexus approach is proving valuable to the global sustainability agenda by providing a tangible focus for a host of wider environmental concerns. Yet poor pricing systems remain a major obstacle to better resource management globally. Failure to account for the costs involved in food, water and energy mean these resources continue to be poorly allocated and wasted on a huge scale globally. Many countries are seeking ways to use market mechanisms to increase efficiency in

D04 Abstracts

one or more resources – often under the rubric of 'subsidy removal'. However, there have been a number of high profile failures and reforms focused on one resource often have unexpected negative impacts on other resources and public goods.
The Valuing Vital Resources work focuses on the Arab Gulf region as an extreme case of nexus interdependence and misallocation through undervaluation. Here, high dependence on oil or gas revenues, exposure to international market volatility in food prices and increasing reliance on desalination as ground-water depletes – in large part through water-intensive agricultural use - are some of the key issues facing development planners and investors. Acute interlinkages between these resources in the region highlight the problem of low or negligible prices leading to inefficient consumption, escalating subsidy bills, future vulnerability to rising food and LNG import prices and public health costs.
The project accepts that the term 'subsidy removal' is not always useful – the 'right price' for domestically produced resources is not always the international market price - rather the first imperative is to gauge current and future costs at the national level. The presentation would discuss the challenges and potential approaches to better valuation of vital resources, drawing on insights from a set of specially commissioned case studies (including India, Iran, Mexico, Australia, Algeria, Saudi Arabia and China) and setting out guidelines for oil exporters in the Gulf region based on local stakeholder workshops.
This work has been supported by the UK Foreign & Commonwealth Gulf Prosperity Fund and the Kuwait Foundation for the Advancement of Sciences.

4 Christian Stein

While integrated natural resources management and policy coherence is nothing new, the so-called nexus approach is a recent way of framing the linkages between water, food, energy and the environment. A nexus approach provides a lens through which it is possible to examine interdependencies between these different domains, with the ambition to reduce trade-offs and increase synergies. While some work on the nexus has tried to identify critical linkages between sectors, relatively little attention has been paid to the social or governance dimension of the nexus. Effective management of the nexus will require the coordination of a range of actors from different sectors and scales. These actors are related to each other through complex governance arrangements. Pathways towards more sustainable development of water, land, energy and ecosystems will need to work with and through these complex actor networks. In the last few years the role of social networks for the governance and management of natural resources has gained increasing attention. Social network analysis, a well-established methodology from sociology, is now being used to study complex governance arrangements, highlighting how relationships among key actors shape governance dynamics.
In this paper we will present preliminary results and discuss experience from a pilot project on the energy-water-food nexus in the Upper Blue Nile in Ethiopia. The goal of this project is to map and quantify the biophysical and social interdependencies across resource systems and to identify possibilities for generating synergies between actors from different sectors and scales within a rapidly developing sub-basin of the Blue Nile. To better understand the social landscape in which the nexus operates, social network analysis was applied in a multi-scale assessment. In a first step we interviewed 85 organizations and analyzed this data quantitatively to identify opportunities and constraints for mutual beneficial collective action and cross-sectorial integration. To better understand processes and dynamics at critical junctures in the network, we did a follow up study in which we conducted participatory network mapping exercises with key stakeholders to jointly identify existing challenges from a nexus perspective and strategies for intervention. We will report some preliminary findings from the different network analysis approaches and discuss how a network approach can yield new and important insights on the governance dimension of the nexus.

D05 Tools for Sustainable Implementation of the Nexus Approach: Instruments and Tools for Integrated Planning

SESSION CHAIR(S)
Holger Hoff,
Stockholm Environment Institute (SEI)

ROOM
Salon Haber

DATE
Tuesday, May 20
11:00 – 12:30

1 Sabrina Kirschke *(Helmholtz-Centre for Environmental Research - UFZ, Magdeburg, Germany)*
» The logic of success – dealing with complexity in political problem solving

2 Shaul Sorek *(Ben-Gurion University of the Negev, Midreshet Ben-Gurion, Israel)*
» Decision Making Strategies for Integrated Water Resources Management (DMS-IWRM)

3 K.D.W. Nandalal *(Department of Civil Engineering, University of Peradeniya, Peradeniya, Sri Lanka)*
» System dynamics based model for conjunctive management of water: Jaffna Peninsula in Sri Lanka

4 Richard Rosen *(Tellus Institute, Boston, US)*
» Polestar - an existing tool to model the nexus approach

ABSTRACTS

1 Sabrina Kirschke

There has been an ongoing debate on proper governance conditions for dealing with complexity in solving problems related to the water-energy-food security nexus. Various political models have been suggested, amongst them deliberative, reflexive and network governance. Such models have given insights into how to tackle the problem, but they seldom reflect on the notion of "successful" political problem solving under complexity; they often do not identify "success" factors; and they do not distinguish between different degrees of complexity. Addressing these problems could help to further develop a systematic theoretical approach to dealing with complexity in political problem solving and to apply this approach to real world problems. We devised an interdisciplinary two-step procedure: First, the concept of complexity and the requirements for problem solving were further operationalized based on psychology research findings; second, governance factors for meeting these demands were identified. This requirement analysis for complex problem solving suggests that particular governance factors are required for specific problem solutions and different degrees of complexity. Hence, the roles of diverse institutions, actors and interaction forms differ for effective and efficient problem solution, respectively depending on five key dimensions of complexity: goals, variables, dynamics, interconnectedness and lack of information. The results of the analysis may contribute towards turning the widespread "logic of failure" in problem solving into a "logic of success" in dealing with problems related to the water-energy-food security nexus.

D05 Abstracts

2 Aviva Peeters, Shaul Sorek, Avishy Carmi, Sharon Megdal

Allocations to Water-Food-Energy (WFE) are temporal and space dependent. Mapping such measures specifying where and when a need may rise for intervention can help aiming at balancing sustainability. A WFE indicators map will thus form the basis of a Spatial Decision Support System (SDSS) for directing quantitatively the decision maker to the extent of intervention needed to establish an efficient/optimal policy for the complex tradeoffs in the WFE nexus.
In what follows we provide three possible DMS-IWRM procedures.

i. Joint Influences of Water related Information
Possible regional, water related stakeholders (i.e. criteria) and their time dependent state variables (i.e. information).

Criteria / State Variables:
1) Aquifer / Water level, Peak contaminants, concentration
2) Urbanization / Population, Area, % of impervious surfaces
3) Agriculture / Crops yield per water quantity
4) Economy / Water prices per criteria 1), 2), 3), 5)
5) Industry / Water quantity per quality
6) Health state / Intestinal disease, Lung disease, Flue disease
7) Family expenditures / Water-Food-Energy (W-FE-) nexus, Water expense, Food expense, Energy expense

Objectives: a) Use the underlying causal structure between the state variables to facilitate reasoning about high level concepts and rules that govern the behavior of the network; b) Predict how the behavior would have been different if the logic could be changed in such a way where the ultimate goals are still addressed.

Deliverables:
a) Employ information-theoretic paradigms to identify and recover the causal interrelations governing the state variables network; b) Detect hierarchical ordering and other ingrained factors that dictate the entire network of the state variables.

ii. Water-Food-Energy nexus
Objective: Normalize temporal quantities per cost of Water, Food and Energy (WFE) per family expenditure, and/or agriculture/aquaculture yield for the sake of balancing sustainability.

Deliverables: a) Three directional WFE surface to asses temporal trends per region;
b) Trans regional map of indicators
We will exemplify such deliverables constructed on data from the Israeli Central Bureau of Statistics (CBS)

iii. Decision Support Systems for IWRM Alternatives
Criteria / State Variables:
- Groundwater
- Surface water
- Anthropogenic Impact
- Marginal Water

1) Aquifer / Water level, Peak contaminants concentration
2) Urbanization / Population Area, % of impervious surfaces
3) Agriculture / Crops yield per water quantity
4) Economy / Water prices per criteria 1), 2), 3), 5)
5) Industry / Water quantity per quality

Objective: Regional integration between Alternatives and Criteria for feasible management which does not violate prescribed limits of the Criteria State Variables. These will be evaluated by simulations, for each criterion.

Deliverable: Spatial Decision Support Systems (SDSS) ranking management model, calibrated per region.

3 K.D.W. Nandalal

The „Jaffna Peninsula“ is an area in Northern Sri Lanka, where mainly underground water is used for drinking, agriculture and industry. However, a large number of shallow surface ponds located within the peninsula area also provide water. The total land area of the peninsula including inland water is about 1,030 km² and its terrain is almost flat. With the ending of the 30 year long civil unrest prevailed in the area, people have started moving into their lands in the peninsula. With this rapid increase in population the demand for water for drinking and agricultural purposes is growing considerably. The underground limestone aquifer and the surface ponds are recharged only by rainfall received during the northeast monsoon period over the area and therefore, the availability of water resource is very much limited. Besides the changes noticed to be occurring in the climatic pattern over the Jaffna peninsula has affected the situation adversely. A system dynamics based simulation model was developed for making policy decisions to conjunctively manage this limited resource to cater for the rapidly increasing demand for water due to high influx of population. The administrative boundaries within the peninsula were considered in the model to enable decision making at that level. Climate change and human activities, which are two significant issues in terms of sustainable water use, were incorporated into the model. The results indicate that wise drinking demand management measures along with improved irrigation practices would be immediately needed to be taken not to stress the underground aquifer and prevent salt water intrusion into it. The model provides changes that may occur to the availability of water in the aquifer due to expected climate changes and shows how appropriate policy decisions on wise conjunctive use of water would minimize adverse effects on the aquifer.

4 Richard Rosen

The Polestar scenario framework as been in use for more than 15 years specifically to create a wide range of scenarios which incorporate the water-energy-food nexus explicitly at the global and regional level. This nexus is then explicitly coupled to land-use patterns, biomass production, hunger levels, water scarcity, CO2 emissions, and agricultural production of numerous crops. The key drivers of future scenarios are population forecasts, GDP forecasts,income inequality measures, technological change, and fossil-fuel resource constraints. Polestar is based primarily on physical quantities, and does not optimize on any specific economic quantity. This allows the economy within Polestar to be disaggregated to a much greater extent than is common in other integrated assessment models, especially for industry, agriculture, and transportation.
The model was developed jointly by the Tellus Institute and the Stockholm Environment Institute, and the database underlying the model was updated to 2005 data several years ago. The scenarios range from the Market Forces scenario (business-as-usual), to Fortress World, to Policy Reform, to the Great Transition. Scenarios can currently be run from 2005-2100. Thus, Polestar represents a tool for integrated planning, for addressing synergies and trade-offs, for mitigating climate change, and for evaluating the impact of more resource efficient technologies. Highlights for each of the four scenarios will be presented in this talk in order to clarify how Polestar can be of use to the nexus research community.

Reference
Raskin, Paul, et.al., (2010), Sustainability,2,8,2626-2651

D06 Implementing the Nexus at Various Scales: Local and Regional Perspectives

SESSION CHAIR(S)
Felino Lansigan,
Global Water System
Project (GWSP)

ROOM
Salon Hauptmann

DATE
Tuesday, May 20
11:00 – 12:30

1 Aditi Mukherji *(ICIMOD, Hathmandu, Nepal)*
» Political Economy of water-energy-food nexus in India: Insights from three Indian states

2 Jan Cherlet *(International Land Coalition, Rome, Italy)*
» Water and land tenure security in the Nexus

3 Makoto Taniguchi *(Research Institute for Humanity and Nature, Kyoto, Japan)*
» Optimal policies for water-energy-food security in Asia Pacific region

4 Victor Dukhovny *(Director of Scientific Information Center of the Interstate Coordination Water Commission in Central Asia)*
» How the nature and irrigation sector could survive under water menace?

ABSTRACTS

1 Aditi Mukherji

India is the world's largest groundwater user, thanks to a regime of power subsidy. As a result, agriculture, groundwater and electricity sectors in much of India are now bound in an invidious nexus of mutual dependence where the growth of one sector (agriculture) is being supported by unsustainable trends in the other two sectors (groundwater and electricity). All three components of the nexus – groundwater, electricity and agriculture are state subjects. Not surprisingly, different states in India have adopted different ways of managing this nexus.
In West Bengal, till 2007, farmers had to pay an unmetered flat rate for electricity consumption – a rate, which was non-trivial and quite high when compared to other states where farmers get electricity subsidy. Subsequently the political establishment in the state government enforced metering of all electric tube wells and switched to charging based on actual electricity consumption. . Thus, a strong political decision sent price signals to the farmers to make efficient use of electricity and groundwater and break the invidious nexus.
Punjab, the heart of Indian Green Revolution, located in the north-western part of the country, is a semi-arid state, endowed with alluvial aquifer that has been much over-exploited. The government gives unmetered free electricity to farmers for pumping, but the amount of electricity is strictly rationed through separation of supply feeders into agricultural and non-agricultural feeders. There is a strong political resistance to metering and charging and hence rationing came up as the second best option. This has forced farmers to invest in efficiency enhancing measures such as use of energy efficient

D06 Abstracts

pumps and laser levelers and thereby in partially addressing the nexus issue. Karnataka, a drought prone state South provides yet another contrasting situation. Agriculture here is precariously dependent on groundwater and aquifers with limited storage capacity have been depleted. Here the government has undertaken a scheme for feeder segregation and ration electricity to agriculture, but the design of the scheme has defeated the very purpose of rationing. In segregated agricultural feeders, three-phase electricity is provided for 6 hours, but single phase electricity is provided for another 10-12 hours. This enables farmers to withdraw groundwater using a single phase electric pump. Thus in spite of its good intentions, purportedly due to strong farmers lobby the political establishment in the state government has not been able to to take strong intended measures to break the invidious nexus. To sum up, we present examples from three states in India — states which have used very different approaches for managing this nexus — ranging from economics text book solution in West Bengal, to second best solution in Punjab, to utter anarchy in Karnataka. This underlines the importance of politics and governance in managing water-food-energy nexus in India.

2 Jan Cherlet

Does the Water-Energy-Food nexus debate adequately address the food security of individuals and households?
To answer this question, the paper first reviews scientific evidence of how the food security of an individual or household depends on its water tenure security and land tenure security. The three forms of security are profoundly interlinked and of are mostly of political nature.
The paper then demonstrates that the role of water and land tenure security in people's food security was largely overlooked in the Integrated Water Resource Management paradigm -due to its 'managerial' approach– and that this role is still undervalued in the Water-Energy-Food nexus debate -due to its ‚apolitical' interpretation of security [1].
Therefore, the article argues that, against the backdrop of the rush for land and water in the Global South, the Water-Energy-Food nexus debate should pay more attention to water and land tenure security of smallholder farmers in the Global South [2].
The article ends with a discussion of a number of multi-laterally agreed principles and guidelines geared at increasing people's land and water tenure security. They include the Principles for Responsible Agricultural Investment (PRAI) and the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VGGT). The Water-Energy-Food nexus debate must explicitly embrace these existing principles and guidelines lest it continue to ignore the role of tenure security in people's food security.

[1] Hoff, Holger. (2011), Understanding the Nexus. Background Paper for the Bonn 2011 Conference: The Water, Energy and Food Security Nexus. Stockholm: SEI.
[2] Anseeuw, Ward, et al. (2012), Land Rights and the Rush for Land: Findings of the Global Commercial Pressures on Land Research Project. Rome: ILC.

3 Makoto Taniguchi, Aiko Endo, Naoki Masuhara, Makoto Yamada, Tomohiro Oh, Pedo Orencio

Increasing demands of water, energy, and food resources under the climate and social changes are causing increased levels of tradeoffs and conflicts among these resources and stakeholders. Policy development and resource management require careful consideration between nature and society, because these resources are inter-connected as nexus. Ecosystem drivers/serves which produce resources, and risks/disasters which damage the resources have a wide range of heterogeneity in the Asia Pacific region with the dependency of the resources. Ecosystem drivers/serves and risks/disasters also depend on geological and geomorphological conditions as well as hydro-meteorological situations in the Asia Pacific region.
Therefore the different type of bottle neck for the sustainable society may be existing among water-energy-food nexus in Asia pacific region. For instance in California, US, the water may be a bottle neck for the sustainable society among water-energy-food nexus, because more than 30 % of total energy consumption are used for water allocation. On the other hand in Japan, the energy may be a bottle neck for the sustainable society, because the self-production rate of the energy is less than 20 % although enough water exists in Asia monsoon hydro-meteorological condition. Therefore, there are different type of tradeoffs and conflicts exist within the water-energy-food nexus and various stakeholders in the Asia Pacific region.
A balance between risks and resilience including ecosystem services is critical for achieving human and environmental security including water security, energy security, and food security. In particular, the Asia Pacific region is experiencing drastic social change alongside the huge potential risks and benefits associated with development. The objective of this study is to maximize human-environmental security (minimize the risk) by choosing policies and management structures that optimize water-energy-food connections in Asia-Pacific region. Themes for this study include conflicts and tradeoffs between geothermal power generation and the hot spring business (water-energy nexus), water uses on land vs environmental flow from land to the ocean for coastal ecosystem (water-food (fishery resources) nexus), and resource development vs water use and contamination (water-energy nexus), and others. This study integrates interdisciplinary and transdisciplinary research with co-design/co-production and science in society. Horizontal integration with different issues and sectors, and vertical integration from local, national, regional to global scale are also targeted.

4 Victor Dukhovny

The water crises comprise an umber of well-known objective factors, such as climate change and related growing temperatures, increased frequency of extremes, population growth, urbanization, and uneven water distribution throughout the Earth. However, there are also many subjective reasons: negligence by many governments; lack of investments; low level of technological development; and, most important, lack of efficient water management and use plus deterioration (pollution) of natural resources because of human activity.
Water relations are always at the interface of counter interests that can be easily represented as grains of conflict. From water allocation and regimes along major rivers to water distribution along small canal – there is always competition in terms of quality and quantity, distribution, and regime; however, this should create a platform for discussion, search of mutually acceptable solutions, and joint implementation.
The Aral Sea basin, which is in the focus of water researchers, is an example of transition from the cooperation principles to the "hydro-hegemony" principles. The attempts made in 1995-2000 to implement pure barter – supply energy to these countries in winter in exchange for equal quantity of energy to be supplied by those countries in summer – failed due to commercial interests of energy sector. Thus, harmonization of different interests and needs of countries and sectors becomes difficult because of commercial factors added to personal ambitions and interests.
The article gave answer - what are the roots of such behavior?

1. The international water law does not give clearly defined instructions on the use and management of particular international watercourses.
2. The role of geopolitical hegemons in these issues.
3. Commercialization of waterworks and hegemonic ambitions in monetary interests.
4. The role of donors and IFIs.

Recommendations, created on the base of regional water management in Aral Sea basin presented 8 principal tools and mechanism that can create strong framework of transboundary water cooperation and collaboration.

POSTERS

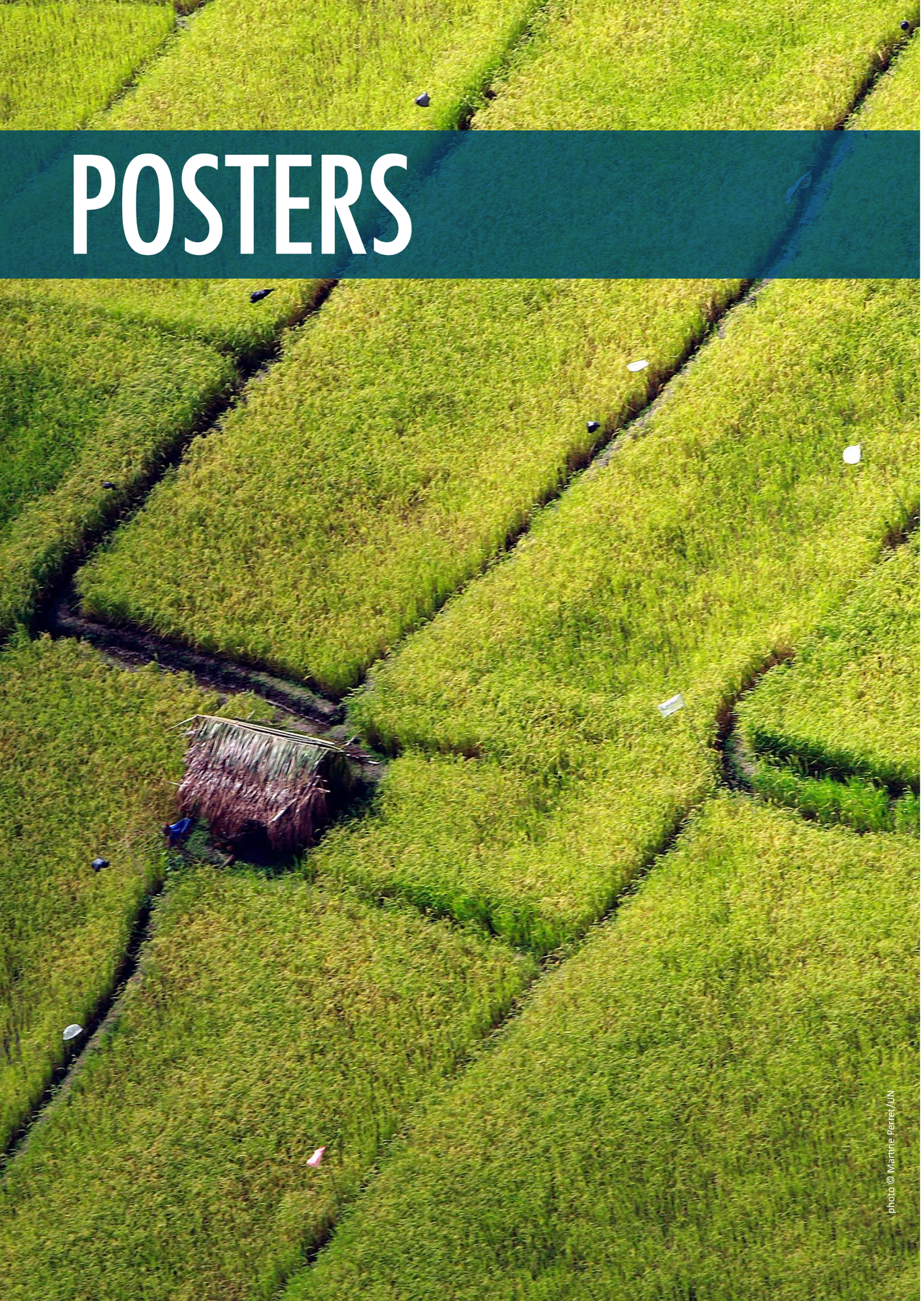

photo © Martine Perret/UN

#1 Switching crops to soothe the water crisis, evidence from an inland river basin in North West China

EEFJE AARNOUDSE, THOMAS HERZFELD
IAMO Leibniz Institute of Agricultural Development in Central and Eastern Europe, Halle, Germany

WEI QU
Gansu Academy of Social Sciences, Lanzhou, China

BETTINA BLUEMLING
Wageningen University, Wageningen, the Netherlands

The competition over North China's scarce water resources is continuously tightening. Agricultural losses induced by a looming water crisis could be diminished when farmers switch to crops which are more favourable under dry conditions. Whereas water stress is likely to be an incentive for farmers to switch crops, it cannot be assumed that the desired crop change will be triggered-off automatically. To understand how losses could be alleviated in future, we study through what kind of governance mechanism the agricultural economy in China may respond to limited water access and whether a change in the cropping pattern may be the result. For this purpose we look at the case of Minqin, a sub-basin in one of North West China's inland river basins. Confronted by a local water crisis, Minqin's authorities and inhabitants felt the need to change agricultural practices. We base our case study research on a survey amongst 100 farm households and 10 village leaders carried out in summer 2013. We primarily gathered data on farmers' water use practices and crop decision making over the last decade.

In Minqin, farmers' access to water has drastically changed since 2007 due to a local water management reform and inter-basin water transfer. Farmers' groundwater use has been strictly regulated; in return the surface water supply has been increased. Officially overall water use has been halved within three years. The water re-distribution was set in motion by the central government to bring the ongoing process of rapid desertification to a halt. Our data shows that, five years after implementation, farmers' crop decision making has been influenced by the change in access to water. We observe that crop change mainly took place in areas with a low salinization rate. In the highly salinized, downstream areas farmers have uninterruptedly grown cotton and fennel. In the more upstream areas, farmers switched from predominantly wheat and melon to: on the one hand, more drought resistant crops (like cotton and sunflowers) and; on the other hand, more profitable crops under high water use efficiency (i.e. horticultural crops in greenhouses with drip irrigation).

Nowadays, after the abolishment of crop quotas set by the state, Chinese farmers are basically free to make their own individual crop choice. Yet, farmers' own initiatives were not the only mechanism driving the observed changes in the study area. As can also be seen outside the study area, the Chinese government is increasingly interfering in farmers' crop choice in an attempt to redistribute water in water scarce areas. Based on our data we conclude that in Minqin local agricultural policies play an important role in farmers' decision to switch crops. Moreover, the increased water stress persuades farmers to re-establish collective decision making and grow similar crops on neighbouring plots.

#2 Future-oriented technologies and concepts for an energy-efficient and resource-saving water management (ERWAS)

ANETT BAUM
German Association for Water, Wastewater and Waste, Hennef, Germany

Water is an irreplaceable resource of human beings. Supply with water in sufficient quantity and quality and safe wastewater management are among the basic needs of mankind. However, water management, from drinking water supply to wastewater treatment, requires considerable amounts of energy.

In the next decades, scarcity of fossil fuels and energy costs are expected to increase. In this respect, Germany is confronted with particularly demanding tasks, as it plans to phase-out of nuclear energy and to transform its energy system towards decentralized and regenerative energy supply. As a result, energy efficiency, regenerative energy production, and smart, decentralized energy management will gain importance, also in the water sector.
The funding measure “Viable Technologies and Concepts for Energy-efficient and Resource-saving Water Management (ERWAS)” of the BMBF is to support applied and practice-oriented research projects covering these issues. The program primarily addresses the areas of public water supply and wastewater management.
The research projects will mainly deal with aspects of regional water supply and wastewater management as well as with comprehensive and sector-overlapping systems solutions. This will require an interdisciplinary approach in the form of integrated projects. Their execution is to contribute to the sustainable development of regions. These may be river catchment areas, urban spaces, municipalities, or rural areas.
To ensure practical applicability and to make the research and development activities meet the requirements of the users, relevant actors from industry and municipal and state institutions are to be integrated in the projects from the very beginning. Participation of enterprises, in particular of small and medium-sized enterprises, is of high priority. Due to global changes, such as the increasing scarcity of fossil fuels, increase in energy and resource efficiency is of decisive importance in the water management sector worldwide. Hence, Germany’s technology leadership and exemplary solution concepts implemented on the national level will contribute to a sustainable development and to strengthening the position of the German water management sector in international competition.

Facts
12 collaborative R&D Projects
28 Mio € Funding
Term: 1/11-10/17
85 Institutions involved

#3 The impact of the Rogun Dam on agricultural and energy production in central asia

MAKSUD BEKCHANOV
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Intersectoral and interstate conflicts over the use of limited water and energy resources are intensifying across the world. The Aral Sea basin is a vivid example of the regions where water distribution between agriculture, energy, and environmental needs is the biggest problem to maintain sustainable functioning of the economies. Decreased environmental flow rates and upstream/downstream conflicts are common as a result of inefficient water management practices that has been experienced over the last four to five decades. Recently, the re-start of the construction of Rogun Dam, with a height of more than 300 m, by Tajikistan in the Vakhsh tributary of the Amu Darya River confronted a strong opposition by downstream countries such as Uzbekistan and Turkmenistan that own most of the irrigated areas in the river basin. Tajikistan claims the construction of this dam increase water availability and thus solves seasonal water scarcity problem in downstream. In contrast, downstream countries are suspicious that the construction of the upstream dam may decrease irrigation water availability since upstream countries are not interested in downstream irrigation benefits but electricity generation in winter. Despite intense debates between the proponents of these two opposite opinions their economic and environmental impact are not documented well in the academic literature. Hydro-economic model is constructed to assess the potential economic and environmental impact of constructing the Rogun dam. According to our results, the construction of Rogun Dam irrigation may slightly decrease irrigation benefits under normal water supply and inconsiderably increase in drier years. Specifically, irrigation benefits across the Amu Darya basin are expected to be about US$ 1759 million without the Dam and US$ 1744 million with the Dam under long-term average water supply. Under reduced water supply (80% of normal), irrigation benefits are anticipated to be US$ 1474 million without the Rogun Dam and US$ 1507 million with the dam. While the construction of Rogun Dam does not impact irrigation considerably, it substantially improves power production levels and benefits. Power production benefits in the Amu Darya basin may increase from US$ 395 million to US$ 557 million under average water flows. Under 80% of normal water supply, power generation benefits are lower but the construction and operation of the dam increases the benefits from US$ 320 to US$ 429 million. Conclusively, the construction of the Rogun may have negligible impact on downstream irrigation water availability and benefits but boost energy production if all countries cooperate to attain basinwide optimal gains. However, the risks because of seismic conditions of the location of the dam, long term-impact on environmental flows, and downstream impact during the period of filling the reservoir are very high and may eliminate the expected gains from energy production.

#4 Spatiotemporal variations in the water and land footprints of meat and milk production systems in Kenya during the 1980s and the 2000s

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Dietary changes towards increased consumption of livestock products and population increase have the potential to adversely affect availability of already scarce freshwater and land resources. This paper demonstrates the changes associated with the direct and indirect use of freshwater and land for meat and milk production in three production systems in Kenya over two time periods, the 1980s and 2000s. We use two resource use indicators, the water (m3/tonne) and land (ha/tonne) footprints, to assess the changes in freshwater and land use for meat and milk production from cattle, goat, sheep and camel in arid, semi-arid and humid production systems. We estimate actual water and land use by using country-specific data for yields, feed composition and feed conversion efficiency. The results indicate that the magnitude of freshwater and land resources used for production is mainly determined by yields and feed conversion efficiencies. The largest water, 70,505 and 69,807 m3/tonne, and land footprints, 11 and 12 ha/tonne, are witnessed in meat production from cattle in the arid and semi-arid production systems respectively. These footprints are about three times larger than those in the humid system, 20,741 m3/tonne and 3 ha/tonne. Arid and semi-arid systems show the poorest feed conversion efficiencies, 175, and yields, 76 kg. Green water and grazing land footprints dominate in all the production systems, due to the predominance of the use of pasture in the diet of the livestock. An increase in the use of blue water and crop land footprints for livestock production, presents the possibility of competition for resources between feed and food production. The changes in the water and land footprints of animal products between the two periods considered are very small due to modest changes in feed composition and feed conversion efficiencies across all the production systems. Averaged, product footprints show a modest decrease due to a relative shift of production to the highland production system. However, total water and land footprints of milk production show an increase for goat, sheep and camel and a decrease for cattle in the arid and semi-arid production systems due to changes in their total numbers. We conclude that by improving yields and feed conversion efficiencies there is the potential to make better use, with less conflict, of the freshwater and land resources for meat and milk production in Kenya.
Keywords: Water footprint, land footprint, livestock production, meat and milk, Kenya

#5 Achieving synergistic rehabilitation in the Aral Sea Basin

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Valiant efforts to save the Aral Sea persisted over decades but failed to meet their goal. The Aral Sea shrank to less than one tenth of its original size, the fisheries and irrigation water resources were lost, villages were destabilized by unemployment and massive health impacts, and the once abundant, species diverse Amu river delta withered. The free fall in agricultural production, water quality and livelihood sustainability that accompanied the shrinking of the Aral has been largely stemmed since Uzbekistan's independence. Cotton production was shifted towards less water intensive wheat and rice that also helped to feed Central Asia's fastest growing population. Recent successes on the northern side of the Aral, in Kazakhstan, have stabilized water losses and offer new hope and insights for the Aral Sea Basin. For the various wetland, desert and agriculturally suited ecosystems on the Uzbekistan side, and its human inhabitants, rehabilitation demands a variegated approach. Not least of which is the recognition for upstream-downstream water access cooperation with Tajikistan and Kazakhstan.
In consultation with strategic government partners in Uzbekistan, and building on the research presented in Edelstein, M. et al., eds., Disaster by Design: The Aral Sea and its Lessons for Sustainability (2012), this paper discusses the recognized need to go beyond point based interventions, and support ecosystem rehabilitation in the Aral Sea Basin. Various simultaneous approaches are being considered, and in some cases implemented at the national, regional and local scale. These include new rural settlements, water filtration and household solar applications, as well as unprecedented large scale solar power generation. There is institutional awareness of permaculture and sustainable community building such as the global ecovillage model. Hindrances to effective sustainability achievements remain in antiquated irrigation networks, large power grid thinking, and insufficient attention to the solar advantage at the local scale. Uzbekistan's unique assets and constraints for fresh water, safe food production and power generation converge in the current opportunities for synergistic rehabilitation. This paper synthesizes findings from stakeholder meetings and our research team's efforts to co-design solutions for sustainability in Uzbekistan.

#6 Water-food-energy-ecosystems nexus in transboundary river basins

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The rapid degradation of ecosystems and a globally increasing population come together with an increasing pressure on natural resources: from food production to provision of fresh water, from energy production to environmental damage. Natural cycles seem to be no longer capable to keep up with the pace of human development as we know it and the effects of climate change are accelerating this process. It is therefore becoming increasingly urgent to move from sectoral policies based on the exploitation of natural resources to intersectoral ones. Such future policies should take into account the often underestimated interlinkages among resources and the chains of cause-effects that link human interventions to environmental degradation and availability of resources.

The purpose of the "nexus assessment" described here to support transboundary cooperation by identifying intersectoral synergies that could be further explored and utilized; and to determine policy measures and actions that could mitigate the resource nexus. The process and the analytical work proposed seeks to provide an understanding of the mutual relations among natural resources in a defined region. At the centre of the assessment is the identification of inter-sectoral trade-offs already in place or that might arise in the future, given the current policy framework regulating the use of those resources, ecosystems preservation policies and mitigation/adaptation strategies. Developing a nexus assessment of a transboundary river basin (or aquifer) is both particularly challenging, due to the international dimension that increases the complexity of the analysis (e.g. harmonisation issues) and interesting at the same time, because it discloses constraints but also opportunities for joint action and cooperation. Recognizing related challenges, the UNECE Water Convention have included in the Work Programme 2013-2015 an assessment of the water-food-energy-ecosystems nexus in selected transboundary basins and established a Nexus Task-Force to overview and guide its preparation. Countries of the UNECE area and beyond confirmed interest in having this assessment carried out in a number of transboundary basins.

The work presented includes the methodology and the outcomes of its application to the Alazani/Ganikh basin a natural border between Georgia and Azerbaijan. The application phase includes the organization and interaction with the representatives of authorities of the relevant sectors and both riparian countries (Georgia and Azerbaijan) in a basin workshop held in in Kachreti, Georgia land the stakeholders' involvement in the several steps of the basin assessment process. This work is carried out by the division of Energy Systems Analysis of KTH, in collaboration with experts from the KTH division of Land and Water resource management and Stockholm University's department of Physical Geography and Quaternary Geology, all supporting UNECE in this effort.

#7 Exploring policy options for the water-energy nexus: A case study of farmers in the lower Amudarya region of Uzbekistan

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Deficits of effective management of water and land resources have led to severe degradation of agricultural land in the lower reaches of the Amudarya region of Uzbekistan which encompasses a decline in farmers' production of strategic crops, including winter-wheat in the framework of the state food security policy. Afforestation practice received considerable attention as a biophysical and economically feasible alternative for improving productivity of degraded croplands. The proposed alternative land use proves to have potential of irrigation water saving and improving farmers' livelihoods by provisioning of firewood for the local population in the region, which is characterized by the frequent shortages in energy supply. In addition to the economic and biophysical feasibility, farmers' adoption of afforestation must account for policy and institutional aspects. This study addresses the present institutional setting and policy options associated with the enhancement of effectiveness in water management and marketing the produced firewood at the local level. The potential impact of policy measures on farmers' water saving and firewood production through tree plantations is explored via extensive field experiments and interviews feeding an Agent-based model (ABM) as an integrated decision-support tool for policy makers. The preliminary findings indicate that capacity building of Water Users' Associations (WUAs) and improvement of the firewood markets would result in 36% (1,007) of the local farmers afforesting 35% (17,492 ha) of degraded croplands, saving on average 30% of irrigation water per farmer as well as making 2,63 Mt of firewood available for the local population for the next 15 years.

#8 Addressing water consumption impacts in Life Cycle Assessment

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Life Cycle Assessment (LCA) is a widely accepted tool in research and industry to address environmental impacts of processes, products and services throughout their whole life cycle, i.e. from cradle to grave. For this integrated approach, all material and energy inputs to and outputs from a product, process or service are evaluated based on their contribution to specific environmental impacts. Among these impacts are global warming potential, eutrophication, toxicity, resource depletion, etc. In the LCA context, these impacts are 'mid-points' which can further be aggregated and transformed to damage 'end-points', for which inputs and emissions to the life cycle are translated to the effects on areas of protection, i.e. human health, ecosystem quality and natural resources. These impacts are commonly expressed in terms of 'Dissability Adjusted Life Years' (DALY), 'Potentially Disappearing Fractions of Species' (PDF) and 'Surplus Energy Demand' (MJ), resp.

Until recently, water consumption was not part of this assessment or, if included, only stated as a volume. However, stating a consumed water volume, i.e. water that was abstracted from a system and integrated to a product or evaporated throughout the processing and thus not returned to the natural system, is not sufficient to address issues of water deprivation. Clearly, a cubic meter of consumed water in Central Europe does not cause the same impact as the same amount consumed in the Sahel Zone. Local aspects such as climate, water availability and consumption of different users or rather competition between users mainly influence if the volumetric water consumption causes an actual impact on the environment.

To address this issue, several indicators and methods were developed in the past few years. These methods provide so called characterization factors, mainly on watershed or country level, which allow to relate the consumed water volume to the local situation and therefore to an impact. They allow calculating mid-points addressing water deprivation and lead to damage assessment at the end-point level. These indicators provide an essential expansion of the environmental aspects covered in an LCA and allow for holistic decision making as a wide range of environmental impacts, e.g. global warming potential, water deprivation, eutrophication or toxicity are covered and aggregated at the end-point level, which makes different options comparable.

The presentation will exemplify the use of LCA and LCA water indicators in various decision making contexts, in which its application is a valuable management and decision support tool. Further, the state of the art and current developments with regard to method development for water deprivation in LCA will be presented.

#9 Water governance and management in multipurpose hydropower and irrigation schemes: Case study of the Nam Mang 3 Project in Lao PDR

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The multipurpose Nam Mang 3 Hydropower Project is one of the trans-basin diversion schemes and one of the 18 hydropower dams in operation in Lao PDR. The multipurpose hydropower and irrigation project has caused a number of negative impacts for farmers especially in downstream areas and in the Nam Nyam and Houay Hong Pheng areas, Thourakhom District, Vientiane Province.

This study aims to understand nexus of the water governance et management regime between the project's hydropower and irrigation purposes in order to find alternatives and to mitigate as much as possible the negative impacts downstream of the dam, especially for villages along the Nam Nyam valley or Napheng plain directly concerned water releases and benefit from irrigation. We used the key informant and focus group survey with various stakeholders of Nam Mang 3 irrigation scheme and field work observation. The findings show that farmers can grow a second season of rice crop but the electricity generation in the rainy season leads to the flooding of rice fields along the Nam Nyam valley. Sometimes during dry season, farmers in the irrigated areas do not have enough water for irrigation of the rice crop downstream of the Nam Mang 3 irrigation schemes, as the water is stored for generating electricity. This is exacerbated by the absence of coordination between the dam operator and irrigation management office or regulation and rule of water release. Overall, the project has contributed to, rather than diminished, poverty of people and increase inequality in the area.

The study recommends a review of the governance arrangements and management in the dam operations which at present are not transparent making it difficult to take into account the multiple benefits and costs to different stakeholders in the water diversion project. The operators of the dam and irrigation scheme have to establish a dialogue with the assistance of the development partners or government to find alternatives to mitigate the negative impacts in the downstream areas or to improve nexus practice in order to secure food security for downstream community. Also there must be mechanisms in place for farmers whose livelihoods are affected.

Keywords: Hydropower, Nam Mang 3, irrigation, water, governance, downstream, impact.

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#10 Sovereign States and Surging Water: Brahmaputra River between China and India

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The Brahmaputra river basin is one of the most vulnerable areas in the world subject to combined effects of glacier melt, extreme monsoon rainfall and sea level rise. Water is emerging as a new possible irritant between China and India. For India, Water of Brahmaputra constitutes a major lifeline for people of Tibet and North Eastern states. The building of dams and diversion projects in Tibet by China is a matter of grave concern for lower riparian states. For China, it is having hidden inclination to create employment potentials for more than millions of people by making Brahmaputra diversion project forward. The requirement of fresh water as the pollution grows and population rise has forced China to have the Tsangpo- Brahmaputra River project. The objective of this paper is to focus the reaction of both people on the water diversion issue, disastrous ecological consequences and the urgent necessity for having a water treaty between Asian giants. It also examines the hegemonic tendencies of China on Brahmaputra River & exercise of power for economic gains and outcomes. The policies China takes on trans- boundary rivers are not symptom of peaceful nature of its rise. In addition, it establishes the fact that sharing of information, ecosystem-friendly policies, thought and mutual understanding will dispel the suspicion and develop trust between two countries, creating an enabling environment for better management of Brahmaputra River.

Key words: Water Governance, Transbondary, River dispute, India, China

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#11 Governance structure of local energy policy in Japan

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1. The Purpose and Background of Research

During the first half of the 2000s, four prefectures or more at least in Japan have made local ordinances aimed at promoting dissemination and installation of new energy and energy conservation equipment. These four are called the „first generation of energy ordinances“.
In this paper, three points regarding governance structure would be clarified. Firstly, in addition to comparison of these four ordinances, by observing the actual policy development in each prefectures which have enacted the ordinance, significance of the energy ordinances would be assessed. Secondly, after feed-in tariffs for renewable energy electricity in Japan were decided, at least 8 local governments across the country have introduced energy ordinance aimed at promoting renewable energy. These eight are called the „ second generation of energy ordinances „ and in the same manner as the first generation , significance of the ordinances of the second generation would be summarized. Finally, the result of the comparison of the characteristics of ordinances between the second generation and the first generation. By integrating the analysis of the above three, future direction of local energy policy including ordinances would be suggested.

2. Second generation of energy ordinance

A feature of the second generation is that the ordinances emphasize on actual practice and declaration of citizens’ right to utilize natural energy in local area. After Konan City had enacted natural energy ordinance, “aimed at policy diffusion“, Shinshiro, Tajimi, Iida, Tosa-shimizu and Sumoto cities followed.

3. Summary of findings obtained in the study

At present, the next two points are found. At first, first generation of energy ordinances tended to be enacted in prefecture, broader-based local government in Japan, while the second generation tended to be enacted in cities, basic-level local government. Establishment of the second generation is currently in progress, so I think that local energy ordinances would increase in the future in Japan.
Secondly, focus of ordinances of the first generation was planning, including goal-setting of energy conservation and new energy introduced in each prefecture. On the other hand, focus of ordinances of the second generation is statement that utilizing renewable energy in local area is the right of citizens and cities’ role to support the energy business.

#12 Climate change impact on downstream ecosystem services and its adaptation measures: A case study of Thachin River Basin, Samutsakorn, Thailand

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Ecosystems provide goods and services that sustain all life on planet earth. Ecosystem services are commonly divided into four categories: provisioning services, regulating services, cultural services and supporting services. Economies and livelihoods in developing countries depend largely on ecosystem service. Change in the ecosystem at temporal or spatial scale at which global climate change is occurring is one of the global concerns. Climate change could alter ecosystem service and thus lead to various problems such as rising sea levels, melting glaciers and decreasing forest land. Adapting to climate change requires the protection and management of natural ecosystem and the relationship between ecosystem services and climate change adaptation should be explored from several perspectives. Conservation and restoration of biodiversity and ecosystem services can play a key role in helping societies to adapt to climate change.The goals of research were to explore and quantify the impact of climate change on downstream ecosystem in Tachin river basin, Samutsakorn province, Thailand. The river Tachin passes directly through the heart of province and flows into gulf of Thailand. It consists of many tributaries networks which connecting the ecosystem of lands and seas make it as a suitable place for fishery and aquaculture. In according to future climate change scenarios, it reveals the increase in extreme weather events and it might largely impede the provisioning of fishery resources, decrease in mangrove habitat and loss in biodiversity. Altered natural ecosystem leads to substantial, long term change in ecosystem and society will response to the change in different ways such as relocation of people and/or looking for a new career. The results found that current climate change's policy and regulation remain ineffective and it needs to be revised for more protection of biodiversity and ecosystem services. Ecosystem based adaptation should be included in the policy in order to increase the use of sustainable ecosystem management activities to support societal adaptation.

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#13 Social acceptance of geothermal energy in the Philippines: a case study of the Makiling-Banahaw geothermal complex

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Social acceptance is one of the main challenges for geothermal energy development in the Philippines. This form of barrier towards renewable energy development is particularly evident among the local community and the indigenous people. This is the case especially for the sites that are under development or in the exploration phase. This study investigates the social acceptance among the local communities residing in the geothermal zone of Makiling-Banahaw geothermal complex.
The Makiling-Banahaw (Mak-Ban) geothermal complex is located in the island of Luzon, about 70 Km southeast of Manila. It is situated at an elevation of 235 MASL, which is in a relatively flat terrain and making it one of the most accessible geothermal complexes in the country. It is one of the oldest geothermal resources explored in the Philippines, which was first drilled in 1974 and began commercial production in 1979. The Mak-Ban geothermal complex is located at the geothermal zone covering seven designated barangays (smallest administrative division in the Philippines). There were no published studies focusing on the social aspect of geothermal energy development in the Philippines. This study focuses on the knowledge and social acceptance of geothermal energy among the local community of the Mak-Ban geothermal complex. The social survey took place in 2013 using questionnaire survey of 269 household respondents covering the seven barangays in the geothermal zone. The questionnaire survey covered household characteristics, knowledge about geothermal energy, perceived impacts, and social acceptability. Preliminary results from the survey provide first hand information to understand the perception of local communities towards geothermal energy.

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#14 Contrasting water-agriculture interactions under present and projected climatic conditions: Comparisons between two major irrigation projects in the semi-arid and sub-humid regions of South Africa

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Decisions which hydrologists make today o the future sustainability of major irrigation systems and the performances of storage dams supplying irrigation water can have far-reaching impacts. Using a detailed whole catchment agrohydrological modelling approach of upstream / downstream feed-forwards and feed-backs, a comparative study was made of two high value crop irrigation systems in South Africa, one in the semi-arid to arid Olifants-Doorn catchment in the winter rainfall zone of the southwest and the other in the sub-humid to sub-tropical Blyde catchment in the northeast, dominated by summer rains. With projected increases in rainfall in the Blyde catchment simulations indicate that the critical 54 000 000 m3 Blydepoort supply dam will cope adequately under climate changed conditions, especially since increased temperatures go hand in hand with enhanced summer rains. Exceedances of temperature thresholds rather than a lack of water for irrigation may result in new mixes of high value crops. In contrast, the projected decreases in winter rainfall which supply water, coupled with higher irrigation water demands in the drying yet warming summers in the Olifants-Doorn, and vast additional conveyance losses from the over 200 km of irrigation canals there, place the 124 000 000 m3 Clanwilliam supply dam under huge stress, with vast potential downstream crop losses, and even raising the dam wall by 13 m may not be enough to compensate for changing environmental conditions. Through the symbiotic relationships between water and irrigated agriculture the consequences of climate change in these contrasting climatic regions are likely to have far-reaching consequences on livelihoods, economics, infrastructure and the aquatic environment within the catchments.

#15 The Water-Energy-Food nexus in socio-ecological production landscapes

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With humankind's need for safe water, energy and food supply the gradual modification of all ecosystems in the course of history led to the development of socio-ecological production landscapes (SEPL). These complex systems are a mosaic of different social-ecological subsystems consisting of biotic and abiotic components as well as social structures all of them relating to each other. The Water-Energy-Food (W-E-F) nexus is interwoven in this fabric across temporal, spatial and organizational scales and the systems provisioning of ecosystem services is the determinant of rural livelihood security in developing countries. The interlinkages out of which the W-E-F nexus then evolves can be grouped as natural, social, human, physical and financial following the categories of capital in the sustainable livelihood approach. Households employ these assets with capabilities and activities in strategies to achieve well-being and an improved resilience to climatic changes optimally without hampering the chances of future generations to do so. How and if an asset is or can be transformed depends upon the household's capabilities but also institutional, cultural and economic factors on different scales, as well as environmental changes that affect the SEPL. The role of lived experience and the household's or its individuals' perception of reality play yet a decisive role. These strategies and interlinkages can go beyond the ecological boundary of the SEPL to secure the livelihood, but the center of the W-E-F nexus lies within the SEPL. However, if many major activities and strategies reach or lie outside of the SEPL, degradation, unsustainability and/or vulnerability of the livelihood can be assumed. To overcome the challenges of climate change, desertification and biodiversity loss despite a growing population with "western", urban consumer demands, the usual inefficiencies, overlaps and blind spots of many environmental and development strategies, policies and research activities can be avoided by establishing a sustainable W-E-F nexus management framework for rural SEPLs. This could also support the understanding of local (bottom-up) ecosystem based dynamics of adaptation to climatic changes and to identify environmentally sound investment opportunities in the complex rural SEPL. The combination of sustainable land use techniques, integrated water resource management and renewable energies could possibly prevent overexploitation of limited resources, preserve and produce domestic and commercial water as well as vegetation, improve the local health situation dramatically and consequently create or strengthen sustainable rural livelihoods.

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#16 The sustainability of seaweed; an analysis from a planetary boundary perspective

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Seaweeds are seen as source of food, feed, green chemicals and biofuels (Holdt and Kraan 2011; Burg et al. 2013). Production of seaweeds now mainly takes place in Asia but production in Northern waters is expanding (Buck et al. 2008).

Seaweeds are presented as a sustainable source of feed and food compared to competing land-based products (soy, corn, etc.) with potential to increase resource use efficiency. Primary production requires no fresh water and does not claim scarce land. In Asia the culture of seaweed culture is associated with eutrophication of estuaries due to heavy fertilizer use. Current European production systems are not based on fertilizer. Instead in Integrated Multi Trophic Aquaculture (IMTA) systems, seaweeds take up the surplus nutrients that are a by-product from fish farming. Production and use of seaweeds can be considered from a planetary boundaries perspective. Various of the identified boundaries can be related to the production and utilisation of seaweeds. At present there are more questions than answers:

- Climate change. Seaweeds constitute a source of biomass that does not require fertilization and chemicals like corn, which causes high CO2 emissions. Question is how much energy in required for transforming seaweeds into biofuel
- Ocean acidity (related to climate change impact but also during growth?)
- Chemical pollution (may take up heavy metals, which may create problems if used for food)
- Agricultural land use. Seaweed has a high land use efficiency in primary production.
- Biodiversity loss. Seaweed culture may enhance biodiversity by providing cover, shelter and source of food for marine life. This would support fisheries. This of course depends on where you carry out the activity.
- Nitrogen flow (uptake of nitrogen during growth. How would large scale seaweed farming impact on N flows?)
- Phosphorus flow (uptake if plants can access it. How would large scale seaweed farming impact on P flows?)

The benefits described above point to the potential of seaweeds to play a positive role on the water-energy-food nexus. However, these claims are not grounded in a systematic analysis of the sustainability of seaweeds. The objective of this paper is review existing data on environmental impacts of seaweeds and develop a framework to assess the sustainability of seaweeds as source of food, feed and green chemicals.

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#17 Nexus issues in the Upper Niger-Inner Niger Delta and proposed basin-wide nexus assessment

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With a large part of the Niger Basin population strongly dependent on the river system's ecosystem services, a strong nexus between water, energy, food and environmental securities exists. In the past years, this nexus has been assessed in various programs for the Upper Niger Basin – Inner Niger Delta (IND) part. In brief, the IND ecosystem provides food, livelihoods and welfare to currently 1.5 million people. This ecosystem has adapted itself to the natural flood dynamics of the Niger River which are depending on the upstream rainfall patterns. To help to meet national and international demands for food and energy, upstream dams generate hydro-power and divert water to irrigation schemes. This has changed the IND's flood dynamics and water availability. Potential new dams and climate change may change this further. Studies show how changed flood dynamics reduce the IND's potential to provide some of the provisional ecosystem services possibly resulting in reduced rice and fish yields. Other results show how upstream dams transfer the distribution of costs and benefits of using the Niger Basin's water across sectors and regions.

In the second part of our presentation we would like to inform about an intended nexus assessment for the entire Niger Basin planned to be performed under the framework of UNECE's Water Convention. Based on cross-sectorial and transboundary stakeholder participation, main nexus issues in the Niger Basin will be identified and synergies to optimize the Basin's potential developed. It is assumed that based on such an assessment a solution package can be developed, comprising of strengthening of regional and cross-sectorial integration, combined with decentralization, leading to better options assessment, local financial inclusion, better designed infrastructures and operations and supported by investments.

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