

STATE OF THE NEXUS APPROACH 2015

MANAGEMENT OF ENVIRONMENTAL RESOURCES



UNITED NATIONS
UNIVERSITY

UNU-FLORES

Institute for Integrated Management
of Material Fluxes and of Resources



TECHNISCHE
UNIVERSITÄT
DRESDEN



Leibniz Institute of
Ecological Urban and
Regional Development

DRESDEN NEXUS CONFERENCE 2015

STATE OF THE NEXUS APPROACH 2015: MANAGEMENT OF ENVIRONMENTAL RESOURCES

REPORT

25 - 27 March 2015
DRESDEN

CONVENING ORGANIZATIONS



UNITED NATIONS
UNIVERSITY

UNU-FLORES

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**TECHNISCHE
UNIVERSITÄT
DRESDEN**



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Regional Development

FOREWORD

With over 350 participants from 65 countries and all continents, we are proud to say that the inaugural Dresden Nexus Conference (DNC) was a successful start to a promising tradition. From 25 to 27 March 2015, representatives from over nine United Nations (UN) entities, six additional international organizations and numerous universities and research institutions as well as various foundations and technical assistance agencies were joined by members of UN Member States Governments from federal, state and municipal levels under the umbrella of 'Dresden Nexus Conference 2015: Global Change, SDGs and the Nexus Approach' (DNC2015).

The mixture and the magnitude of sectors and cultures represented at DNC2015, is a clear indicator that advancing a Nexus Approach to environmental resources management is a truly cross-cutting topic that is of importance and interest to countries and peoples around the world. The impact of global change on the environment as well as the services provided by ecosystems and how to cope with these impacts is a crucial part of the ongoing debate on the post-2015 development agenda. Taking a Nexus Approach to managing environmental resources is central to this discussion, as it can help to decrease environmental risks and ecological scarcities while increasing food production under conditions of global change as well as to ensure economic development.

Diversity and dimension were also notable qualities of the content presented at the conference. The conference programme included over 90 presentations across 18 different program items as well as various side events. This volume comprises a comprehensive collection of summaries of all DNC2015 sessions. Taking the variety of topics covered and sectors reporting into account, it offers readers a valuable and stimulating cross-section of the current nexus-oriented research projects and initiatives in the field of sustainable resource management.

DNC is envisioned as a platform for representatives of academia, politics and civil society to come together and discuss current research and initiatives applying the Nexus Approach to resource management every two years. As such, ***State of the Nexus Approach*** is also envisioned as a biennial publication that offers the nexus community a cross-section of the most recent and innovative nexus-oriented initiatives in the field of sustainable management of environmental resources from the academic and public sectors. In this vein, the organizers of DNC, the United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES), Technische Universität Dresden (TU Dresden) and the Leibniz Institute of Ecological Urban and Regional Development (IOER) hope to make a large contribution to the progress of a Nexus Approach to resource management, and thereby play a small part in achieving truly sustainable development for all.

Reza Ardakanian, Director of UNU-FLORES

Karl-Heinz Feger, Dean of the Faculty of Environmental Sciences, TU Dresden

Bernhard Müller, Director of the Leibniz Institute of Ecological Urban and Regional Development

On behalf of the Organizing Committee

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INTRODUCTION

CONFERENCE CONCEPT

From 25 to 27 March 2015, the United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES), the Technische Universität Dresden (TU Dresden) and the Leibniz Institute of Ecological Urban and Regional Development (IOER) organized the inaugural Dresden Nexus Conference on Global Change, SDGs and the Nexus Approach. The conference focused on how the integrated management of environmental resources guided by a Nexus Approach may help to achieve the potential targets of the post-2015 agenda.

The Nexus Approach to the sustainable management of water, soil and waste emphasizes the interrelatedness of these three resources along with the cycle of research to implementation, which focuses on governance, the enabling environment and individual capacity development. Over three days, participants at the Dresden Nexus Conference 2015 (DNC2015) presented a cross section of the current nexus-oriented initiatives being conducted worldwide. Highlighting the potential of a Nexus Approach to resource management, the presentations during the conference reported on the following:

- best management practices for maintaining and enhancing environmental resources by adopting a Nexus Approach to the sustainable management of water, soil and waste
- capacity development needs, which are required for the implementation of a Nexus Approach and are instrumental to achieving the SDGs
- priorities for future research, education and policy advice

One aspect of global change acted as the uniting theme for each day of the conference:

Day 1: Climate Change – How can adopting a Nexus Approach mitigate the growing water, food and energy insecurity due to climate change from an environmental resources perspective?

Day 2: Urbanization – What opportunities are possible for multi-level governance arrangements that foster inclusive forms of urbanization based on an improved understanding of trade-offs and synergies?

Day 3: Population Growth and the Increasing Demand for Environmental Resources – How can the management of environmental resources guided by a Nexus Approach support the sustainable and economically feasible intensification of biomass production?

The general structure was similar across the three days: starting in the morning with a plenary including two keynote presentations related to the thematic topic of each day. Two blocks of sessions-in parallel, before and after the lunch break followed. Participants reassembled in a plenary at the end of each day. This plenary session included a panel discussion that reported and analysed the outcomes of the parallel sessions, followed by a concluding talk. The aim of the concluding talk of the day was to synthesize the major aspects emerging from the daily keynotes and related discussions, the outcome of the sessions and the panel discussion. The main deviations from this structure were the opening remarks on Day 1, the poster session on Day 2 and the Conference Wrap-Up and Closing on Day 3 (see Programme At-a-Glance).

In total, the conference comprised six keynote speeches, eighteen parallel sessions, three panel discussions, three concluding talks, the conference wrap up talk, a poster session and an exhibition hall. This publication aims to comprehensively reproduce on the content that was discussed and reported on over these three days. Therefore, all opening and closing remarks, keynote speeches, concluding talks and parallel sessions are summarized in detail. The aim of the afternoon panel discussions was to report on, discuss and put into perspective the outcomes of all sessions of the day. The panels were comprised of the leading session conveners and other experts representing academia, research and policy sectors. The results of these panel discussions along with the main messages of the day were then synthesized in the concluding talks of the respective days. Therefore, the content of the panel discussions can be found in the summaries of the concluding talks. The exhibition and poster halls offered participants an alternative setting besides the seminar rooms to engage with these topics. Over 60 posters were on display throughout the entire conference, each corresponding with one of the various parallel sessions on climate change, urbanization and population growth. They are listed in this publication in the respective session summary. The exhibition hall was home to stands from local, regional and international institutions from academia and civil society. An overview of the exhibitors can be found in the concluding chapter.

With over 350 participants from 65 countries and 5 continents, high-level representatives from several UN Member States, numerous UN entities, several UNU institutes, international organizations, universities and research institutions, and various foundations and technical assistance agencies, the inaugural DNC2015 was a great success in this regard. By bringing these stakeholders together, the foundation for a dynamic and effective network of researchers and practitioners applying the Nexus Approach to resource management has been set. In this vein, DNC2015 has played an important role in aligning research and implementation of nexus-oriented, policy-relevant solutions to addressing global change and in strengthening Dresden's role as a hub for research on sustainable development. The costs of the conference were covered by the participants, funds provided by the German Research Foundation (DFG), the City of Dresden and the three organizers.



To see full-length videos of plenary sessions watch
The Dresden Nexus Conference Playlist on UNU-FLORES YouTube Channel.

All **DNC2015 Presentations** have been compiled and put online at dresden-nexus-conference.org/documents-2015.html. For information on how to access the presentations, please contact DNC2015@unu.edu.

PROGRAMME AT-A-GLANCE

DAY 1: CLIMATE CHANGE WEDNESDAY, 25 MARCH 2015

8:45 – 10:30 Plenary (Main Auditorium)	OPENING REMARKS – From high-level representatives of BMBF, SMWK, TU Dresden and BMZ KEYNOTE SPEECHES (Q & A Session) – Elena Manaenkova Joseph Alcamo
10:30 – 11:00	COFFEE BREAK
11:00 – 12:30 Parallel Sessions	S1 (Main Auditorium) S2A (Lecture Hall) S4 (Seminar Room 9)
12:30 – 14:00	LUNCH
14:00 – 15:30 Parallel Sessions	S2B (Lecture Hall) S3 (Main Auditorium) S5 (Small Auditorium)
15:30 – 16:00	COFFEE BREAK
16:00 – 18:00 Plenary (Main Auditorium)	PANEL DISCUSSION CONCLUDING TALK OF THE DAY – Rabi Mohtar
19:00	RECEPTION (Dresden Academy of Fine Arts), sponsored by the City of Dresden

DAY 2: URBANIZATION THURSDAY, 26 MARCH 2015

9:00 – 10:00 Plenary (Main Auditorium)	KEYNOTE SPEECHES (Q & A Session) – Saeed Nairizi William Rees
10:00 – 10:30	COFFEE BREAK
10:30 – 12:00 Parallel Sessions	S6A (Main Auditorium) S8 (Lecture Hall) S10 (Small Auditorium)
12:00 – 13:30	LUNCH
13:30 – 15:00 Parallel Sessions	S6B (Main Auditorium) S7 (Lecture Hall) S9 (Small Auditorium) S11 (Seminar Room 9)
15:00 – 16:00	POSTER SESSION AND COFFEE BREAK (Mezzanine Floor Gallery)
16:00 – 18:00 Plenary (Main Auditorium)	PANEL DISCUSSION CONCLUDING TALK OF THE DAY – Stephen Curwell

DAY 3: POPULATION GROWTH AND THE INCREASING DEMAND FOR ENVIRONMENTAL RESOURCE FRIDAY, 27 MARCH 2015

9:00 – 10:00 Plenary (Main Auditorium)	KEYNOTE SPEECHES (Q & A Session) – Michael Herrmann László Miklós
10:00 – 10:30	COFFEE BREAK
10:30 – 12:00 Parallel Sessions	S12 (Small Auditorium) S13 (Seminar Room 9) S14 (Main Auditorium) S15 (Lecture Hall)
12:00 – 13:30	LUNCH
13:30 – 15:00 Parallel Sessions	S16 (Small Auditorium) S17 (Main Auditorium) S18 (Lecture Hall)
15:00 – 15:30	COFFEE BREAK
15:30 – 17:30 Plenary (Main Auditorium)	PANEL DISCUSSION CONCLUDING TALK OF THE DAY – Timothy O. Williams
17:30 – 17:45	COFFEE BREAK
17:45 – 18:30 Plenary (Main Auditorium)	CONFERENCE WRAP-UP – Rattan Lal CLOSING REMARKS – From Verena Klinger-Dering of BMUB and the Organizers

OPENING SESSION



WELCOME ADDRESS FROM THE UNITED NATIONS UNIVERSITY (VIDEO MESSAGE)

David M. Malone
United Nations University, Rector
United Nations, Under-Secretary-General



Greetings from distant Tokyo. I do wish I could be with you. I am very grateful to our friends at BMBF, our major partners at the federal level in Germany; to the State Ministry for Higher Education, Research and the Arts in Saxony, the Minister responsible Dr. Stange; to the Technische Universität Dresden, one of Germany's top Universities, for being such a great partner to us in Dresden; and to the conferees. I envy you. I wish I could be with you.

The subject matter of the conference, the subject matter of our institute in Dresden, the integrated management of water, soil and waste is a tremendously important one at the international level. So often, these factors are considered problems in societies and economies, but if we integrate their management they can become resources and hence the promise of the field.

Dr. Ardakanian, a former Vice Minister of Water in his own country Iran, where the management of water is perhaps the principle economic challenge facing this proud and historic country, has done a tremendous job getting FLORES off the ground. He has hired a small but excellent team, nearly all for whom I have met with pleasure. They were joined very recently by their first cohort of doctoral students from five different countries, four of them developing countries. That is important for us at the UN University, because our work ultimately is always oriented towards the interests of developing countries.

Dresden is one of our newest institutes. It joins our work in Bonn in ranging across environmental issues. We are exceptionally fortunate in host authorities in Saxony. All of you at the conference

will have noticed what an extraordinary job has been done of reviving the historic city of Dresden, shattered in the dying days of the war and today one of the most beautiful sights in Germany. The countryside around Dresden is also exceptionally beautiful and this speaks to the care that can and must be taken of the nature around us and of which we all live.

Again, my welcome but also my regrets not to be with you – in my case you can be sure they are altogether sincere. I would much rather be learning about the integrated management of water, soil and waste then tending to my administrative duties at UNU headquarters. Many thanks.



OPENING REMARK FROM THE GERMAN FEDERAL MINISTRY OF EDUCATION AND RESEARCH

Volker Rieke
Director General of the
Directorate General



Professor Ardakanian,

Many thanks for your invitation.

Distinguished Guests,

I am very pleased to have the opportunity to welcome you here at the Dresden Nexus Conference.

The BMBF has been supporting UNU-FLORES since the first efforts to establish the institute in Germany. I am all the more delighted that, in the short space of time since its official opening in December 2012, UNU-FLORES succeeded in organizing the preparatory event for this conference two years ago, thus making it possible for the first Dresden Nexus Conference to take place as planned in 2015. It is remarkable that such a young institute has been able to bring together such a diverse, international group of high-level participants from the fields of science and politics.

International cooperation in research and education plays an important role in politics throughout the world. Progress in the fields of climate protection, energy supply, disaster prevention, food safety and the efficient use of resources is being made almost exclusively in joint research schemes involving international teams. The Federal Ministry of Education and Research (BMBF) wants to develop Germany's huge creative potential at the global level by promoting international cooperation. At the same time, world-wide cooperation in science and research is also an important key to sustainable and peaceful development in the world. The United Nations University is demonstrating this approach with each of its institutes. The fact that UNU-FLORES feels 'at home' and is able to flourish in Dresden is evidence that the German Federal and the Saxon State Government have established a good framework in Germany in general, and in Dresden in particular.

UNU-FLORES is not the only UNU institute in Germany. The BMBF values the long years of partnership with the Institute for Environment and Human Security in Bonn and with the United Nations University Vice-Rectorate in Europe, which is also located in Bonn. All three institutions have remarkable networks, particularly in countries where global challenges such as climate change are having a much more immediate effect on the population than here in Germany. The UNU institutes are conducting high-quality interdisciplinary research and are building bridges between the civilian population, science and politics; between North and South, East and West. In recent years, the BMBF has observed how the United Nations University has encouraged the establishment of new institutes. UNU-FLORES has performed important work in establishing a partner institute in Maputo. The BMBF is convinced that such institutional cooperation is an essential precondition for scientific capacity building in Africa. This is why we are also in contact with other UNU institutions in Germany. The Vice-Rectorate in Bonn, for example, is involved in scientific capacity building in the field of water and energy at the Pan-African University in Algeria. This work is in line with the BMBF's Africa Strategy, which sets out to strengthen education and research in Africa in the long term in partnership with African authorities and universities.

We are also following the activities of UNU-FLORES and the UNU in other regions of the world with great interest. These activities are guided by the desire to find innovative and targeted solutions in cooperation with the local population – for example, with regard to ever scarcer resources such as water and soil, energy supply or migration patterns in regions affected by environmental catastrophes.

UNU-FLORES sets out especially to study the links between water management and the resources soil and waste. 'Integration' should not only be a catchword in this context. It must be implemented. One of the aims of UNU-FLORES, therefore, is to help decision makers and users extend their knowledge on the use of innovative technologies. This is precisely what the international doctoral programme on the integrated management of water, soil and waste is doing.

UNU-FLORES occupies an important niche in the research scene. From this position it can make a decisive contribution to achieving the global sustainability goals that are currently being discussed at the United Nations.

Thank you for your kind attention. I wish you interesting talks and every success over the next few days.



OPENING REMARK FROM THE SAXON STATE MINISTRY FOR HIGHER EDUCATION, RESEARCH AND THE ARTS

H. E. Eva-Maria Stange
State Minister

STAATSMINISTERIUM
FÜR WISSENSCHAFT
UND KUNST



Dear Mr. Rieke,

Dear Professor Ardakanian,

Dear representatives of international and national organizations in science and politics,

Dear Ladies and Gentlemen,

Please let me start by saying that I am very glad to be part of the opening of this conference. I am delighted to warmly welcome you to Dresden – especially because some of you have travelled a long way to join us.

The Free State of Saxony is known for its long tradition in science and research, as well as in culture and the arts. What makes the existence of these traditions unique and notable is the fact that they are often linked to corresponding educational and teaching programmes. So it is no coincidence that, for example, the University of Leipzig has existed now for more than six centuries, while the Technische Universität Bergakademie Freiberg – which is the oldest university of mining and metallurgy sciences in the world – can look back on a history of 250 years. The doors of the colleges of art in Dresden and Leipzig have been open for longer than two and a half centuries and – just to add another example – the musical colleges of Dresden and Leipzig have a history of more than 150 years.

Besides Saxony's 14 universities, art colleges, universities of applied sciences and universities of cooperative education, within the last 25 years almost 40 institutes of the Fraunhofer, Max-Planck, Helmholtz and Leibniz Association have been established in Saxony. In addition, there are more than 30 additional research institutions and several university associated institutes. These numbers prove that over the last years a close network of science and research institutions has developed in Saxony. This network is characterized by the highest density in Germany.

As a result, Saxony can claim to be a significantly high-performance university and research province, which is tackling questions of global, future relevance with curiosity, persistence and – first of all – professional knowledge in all related fields of expertise.

Saxony has been internationally recognized for its achievements in the fields of microelectronics, nanotechnology, mechanical engineering as well as automotive manufacturing, material sciences, biotechnology, cancer research, neurosciences, medical technology, resource technology and environmental research.

Looking at the mentioned aspects, we also have to realize that all these achievements were only possible because the Free State identified very early that education is in fact – and first of all – of central importance for the social, cultural and economic development of our country. Because of this, every year about one third of the overall budget of the Free State is being invested in education, science and research. For the coming years we are planning to allocate an amount of 5.3 to 5.4 billion Euro, which is more than ever before.

Ladies and Gentlemen,

We are very proud that people from all parts of the world and many different countries are jointly studying, working and doing research at our universities and research institutes. When in 2012 the United Nations University established its second German institute in Dresden, Saxony's political approach towards science and research, which is based on a cosmopolitan, transcultural and achievement-oriented attitude, was confirmed.

I would like to say that the profile of UNU-FLORES fits perfectly into the existing scientific and research network of our country. UNU-FLORES is funded by the Federal Government as well as the Free State of Saxony. Only recently we have confirmed the continuation of this concept for another three years. I would explicitly like to thank all of you who made this possible.

Main issues of the work of UNU-FLORES are related to water, soil, waste and the responsible use of resources. It is no exaggeration that the arising tasks are of universal importance.

Developing and emerging nations have to face these and numerous other global issues – and the industrial nations are asked to act in a way that is firmly based on a responsible and sustainable approach. And it is obvious that only together we are going to succeed in tackling the fundamental problems ahead.

While the foundation of UNU-FLORES as an institute has almost been completed organizationally, it is now the upmost objective to establish ones place in the world of existing research and counselling institutions. This is most efficiently done by reaching recognizable results and standards, which are positively perceived within a wide ranging local and scientific context. With the Dresden Nexus Conference, UNU-FLORES has made an impressive step in exactly this direction.

Ladies and Gentlemen,

For the upcoming conference, I wish you interesting and inspiring talks, workshops, discussions and panels. Most of all, I hope that by the end of the Dresden Nexus Conference you take home lots of new ideas and knowledge. And of course, I also hope that there have been many opportunities to meet people and make contacts that are an inspiration and motivation for your work.

Please let me finish by expressing the wish that those of you who are traveling home after the conference days leave with positive images and impressions of the baroque city on the river Elbe. Please remain well-disposed towards Dresden.

Thank you very much for your attention.



OPENING REMARK FROM THE TECHNISCHE UNIVERSITÄT DRESDEN

Hans Müller-Steinhagen
Rector



Dear State Minister, Dr. Stange,

Dear Mr. Rieke from BMBF,

Dear Mr. Marré from BMZ,

Dear Prof. Ardakanian from UNU-FLORES,

As Rector of the Technische Universität it is a pleasure to welcome you today here in Dresden. When Prof. Ardakanian asked me to say a few words of welcome to you, I agreed without hesitation.

And in fact my first 'thank you' today is addressed to Prof. Ardakanian. The Technische Universität considers it a privilege and an honour for Dresden and our region to have UNU-FLORES in our city, as a think tank for the development of modern and innovative solutions to some of the most demanding challenges one may imagine.

The interrelated and integrative investigation of water, soil and waste are far from mere engineering problems – as one may think at the first instance – they are also related to society, culture, personal attitude and the knowledge of global ethics to distinguish right from wrong.

And hence you chose well to come to Dresden with UNU-FLORES! The combination of humanities, engineering and sciences is a unique strength of our synergetic university – which is also the title of our institutional strategy that was successfully submitted in the German Excellence Initiative.

I strongly encourage UNU-FLORES to seek collaboration with all parts of our university and with the unique scientific network DRESDEN Concept with its strong partner institutes of the Leibniz, Fraunhofer, Max-Planck and Helmholtz Societies.

My second thanks go jointly to the Federal Ministry of Education and Research and to the State Ministry for Science and the Arts. Both of them played a decisive role to bring this project into being. UNU-FLORES provides us in Dresden with an internationally highly connected partner

with the ability to spread and gather knowledge to and from a large number of partners all over the World. We can count on your network within the so called WORLD UNIVERSITY.

The natural partner – so to say – at our university is the Faculty of Environmental Sciences. I am pleased to have Prof. Feger, the Dean of this Faculty, amongst us today. He will later sign the announced Memorandum with our partners on behalf of our University, as I will have to fly off to an important meeting in Korea. With this renewed contract we will advance our beneficial cooperation, because education and knowledge are the key measures to prevent countries from relapsing into violent conflicts. And if we look into today's world, an international approach to finding solutions to global problems of water, soil and waste management is more urgently needed than ever. Solutions we should start to attempt each and every day anew. Today is one of these starting days.

I hope that you will have a stimulating and interesting meeting with conference proceedings that are – no doubt – well prepared. And in addition to your scientific aims, I hope that you will also have a wonderful stay in the beautiful city of Dresden.



OPENING REMARK FROM THE GERMAN FEDERAL MINISTRY FOR ECONOMIC COOPERATION AND DEVELOPMENT

Franz-Birger Marré
Head of Division for Water,
Urban Development and Transport



State Minister Mrs. Stange,

Prof. Müller-Steinhagen,

Director General Rieke,

Colleagues from Bonn, Dear Reza Ardakanian,

Ladies and Gentlemen, Dear participants of the conference,

On behalf of the German Ministry of Economic Cooperation and Development, a warm welcome. We have cooperated closely with Reza Ardakanian, with the United Nations University and the United Nations Water Decade Programme on Capacity Development over the years, and I would like to congratulate first of all, Reza, on his tenacity and his vision that made UNU-FLORES and that made this Dresden Nexus Conference a reality.

If we look at the newspapers, what dominates them of course these days is disasters – human-made disasters, natural disasters – we are discussing climate change, we are looking at international conflicts and social tensions and many other things. But I believe that there are two major topics that really are influencing the fate of humankind over the next two or three decades.

This is on one side population growth and on the other side the fact that while there is economic growth, it is very unequally distributed. These two facts will result in a growing pressure on environmental resources and especially on the availability of water, of energy and of food.

Within the next 20 years, about 40 percent more water will be needed than is available on a worldwide basis. In other terms, 60 percent of mankind will suffer under water stress within the next 20 years. So, action is urgent. Business as usual isn't an option anymore. And how this is can be managed in the future will be very crucial in the success of achieving the huge goals being discussed this year; the Sustainable Development Goals, the agenda on climate change, but also the agenda on financing for development, which will be discussed in Addis in July.

With the Bonn Nexus Conference in 2011, the German Government tried to initiate a discussion on solutions for the Green Economy based not on new sectors or new issues but on a concept of sustainability that aims not at making complex and complicated things even more complex, but at having a good process to define priorities and to find ways to create synergies and to reduce losses. I would like to recall the messages of that nexus conference: The first one was create policy coherence. The second one was accelerate access. This is also one of the huge challenges I mentioned; economic growth that is happening, but is very unequally distributed. Large countries such as China, such as India, also Indonesia, Brazil and Mexico are growing at an unprecedented pace. But what is happening in Africa, what is happening in low-developed countries all over the world? During that nexus conference, the scientific community was one of the largest and most active groups. Many scientific institutions have taken up the Nexus Approach in their work and in the coming three days we will see that a lot has happened in the meantime to propagate the Nexus Approach and the nexus messages.

However, I think it is also crucial to take into account the policy perspective on tackling nexus challenges and a lot needs to be done there. I do not want now to bore you with the numerous activities, I would just say that we can see that since 2011, since this concept of nexus has been formally introduced into the discussion, a lot has been discussed over the world. I am especially pleased to see that German development cooperation but also German scientific cooperation is able to support activities, projects and programmes in regions that are already today very water-stressed, such as the Middle East and Northern Africa.

I would like to conclude here, but not without having expressed my sincere thanks to UNU-FLORES, to the Technische Universität Dresden and the Leibniz Institute of Ecological Urban and Regional Development for arranging this conference. Thank you very much for providing a platform for exchange and for building alliances and allowing for more integrated planning, decision making, implementing, monitoring and evaluating in the future. Ladies and gentlemen, I wish you fruitful, inspiring and also result-oriented discussions over the next three days. Thank you for your attention.

DAY 1: CLIMATE CHANGE

KEYNOTE SPEECHES



ADDRESSING CLIMATE CHANGE IN THE CONTEXT OF SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES

Elena Manaenkova
World Meteorological Organization
Assistant Secretary-General



In the last decades, the effects of extreme weather and climate change have become an undeniable reality.

Global temperatures on land and in the upper ocean have been steadily increasing, with 2014 featuring as the warmest year on record; the sea level is rising; glaciers, snow covers and the Arctic ice mass are shrinking; the ocean is becoming more acidic. Storms, heavy rain and floods have come to be more frequent and intense; droughts more common and prolonged, degrading our lands, threatening our food security. Projected climate change will continue to have impacts on natural resources and systems – water, terrestrial ecosystems, coastal and ocean systems. In light of the current and foreseen changes in the climate due to human activities and the impacts of a warmer planet, it is imperative to undertake ambitious climate action at all levels, from local to global, and with the contribution of all actors:

governments, the private sector and the civil society. The 21st Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC/COP21) will convene in Paris in December 2015 to adopt a new global agreement to deal with climate change and contain global warming within 2°C above pre-industrial levels.

Climate change mitigation and adaption also need to be adequately factored in the framework of the post-2015 development agenda and the Sustainable Development Goals that will be adopted by the General Assembly in September 2015. Indeed, the impacts of climate change compound with those of the chronic issues that affect humanity: poverty, hunger and social and economic inequalities. As a matter of fact, climate change can hinder if not impede sustainable development and nullify the important achievements of the Millennium Development Goals. Therefore, this is a time to act, to make the most of what we have attained in the last ten years and set the course for the future. In a context characterized by the degradation of the resource base and scarcity of water, land and other resources, addressing resource management in an integrated way through the water-food-energy Nexus Approach can provide opportunities to improve water, energy and food 'security', reducing trade-offs, building synergies and generating environmental,



social and economic benefits: (a) investing to have more productive and sustainable ecosystems; (b) integrating poverty alleviation and green growth; and (c) creating more with less and reuse wastes.

National policies will be key enablers in the transformation needed to stabilize climate change at acceptable levels. The most critical are reducing emissions to levels that will limit global warming to 2°C or less. This will require science-based policies and investments that foster energy efficiency and low-emission growth and infrastructure, and sustainable use of natural resources. In this regard, three factors can be considered critical: (1) our knowledge about climate change and our ability to stay ahead of it depend on ensuring that observing systems are maintained and expanded; (2) national policies should promote the free and open exchange of data; and (3) increased investments will be needed to strengthen climate services capacity, in support of the implementation of National Adaptation Plans and other measures under the United Nations Framework Convention on Climate Change, Sustainable Development Goals and disaster resilience.

To address climate change, the scientific knowledge that has been built-up in the last decades is therefore an invaluable resource and a prerequisite for decision-making and action. Science also gives us high confidence that we can still change course and mitigate climate change to a manageable level: today, few people contest the evidence of climate change and the responsibilities we bear towards future generations. Climate knowledge can and must support this process, helping decision makers at all levels to make the best decisions. However, climate knowledge must come in a form that is easily understood and usable by those who need it. Information products and services based on climate predictions can assist city planners in developing policies and action plans that can strengthen urban resilience in the face of natural disasters and foster a greener economy. Public health authorities use climate forecasts to address in a proactive way the possible health consequences of extremes such as droughts, heatwaves and floods. Thanks to predictions about temperature and rain trends, farmers can make better planting, cropping and marketing decisions. Water resources managers use climate information to optimize water supply and flood management. The energy sector uses climate information to decide where and what type of power plant should be built in a particular location.

The Global Framework for Climate Services (GFCS), initiated by the World Meteorological Organization (WMO) with other UN partners, coordinates and implements activities to support the development of operational climate services that provide information and forecasts for decision-making in priority areas such as agriculture, health, disaster risk, water resources, cities and energy. This initiative is being increasingly recognized internationally as a means to enable the provision of climate services to support decision-making, based on the best possible information. This is a crucial challenge for both developing and developed countries and there is a great potential benefit in learning from each other. Experiences and advances in the development and application of climate services can be shared as examples of good practice and to assist other countries in accelerating their path towards climate adaption.

WMO plays a key role in this endeavour. As a specialized agency of the United Nations, it is the authoritative voice on the state and behaviour of Earth's atmosphere, its interaction with the oceans, the climate it produces and the resulting distribution of water resources. It supports a basic infrastructure to strengthen the operational capabilities of national meteorological and hydrological services, to generate and deliver up-to-date climate information and prediction products, especially in support of climate adaptation and risk management. In 1988 together with the United Nations Environment Programme (UNEP), WMO established the Intergovernmental Panel on Climate Change (IPCC), which provides clear and up-to-date reviews of the current state of scientific knowledge relevant to climate change through periodic assessment reports.

WMO issues a number of periodic publications that are a reference for scientists and policymakers, among which: the WMO statement on the status of the global climate (yearly), an authoritative source of information on the key climate events of each year for the scientific community, the media and the public; the Greenhouse Gas Bulletin (yearly), which reports on the latest trends and atmospheric concentrations of the most influential, long-lived greenhouse gases; the Antarctic Ozone Bulletin (bimonthly), which provides information about the state of the ozone layer; the El Niño/La Niña Updates (quarterly), with the status and outlook for the El Niño-Southern Oscillation (ENSO) phenomenon. To sensitize the public and policymakers, WMO has also invited television weather presenters from around the world to produce a 'weather report from the year 2050' based on IPCC scenarios.



SYSTEMS THINKING FOR ADVANCING A NEXUS APPROACH TO WATER, SOIL AND WASTE

Joseph Alcamo
Center for Environmental Systems Research
Executive Director



The nexus of water, soil and waste is made up of innumerable connections, in particular, the complex interactions between society and the environment. In this vast space of ideas and institutions, systems thinking can bring better understanding to nexus problems and provide insight into good management strategies.

There is no universally accepted definition of *systems thinking*, but most would agree that it involves thinking in terms of a whole system rather than its parts, focusing on linkages rather than components and observing patterns rather than content. There is also a large toolkit of systems methodologies that can be brought to bear on nexus problems, including integrated assessment modelling, systems dynamics diagrams and models, scenario analysis and systems engineering.



Systems thinking can help describe the linkages in the nexus through visualization techniques, such as, systems dynamics diagrams and causal loop diagrams. These diagrams can be used to identify the linkages between components in a system. The next step is then to identify which of these connections are the critical linkages that determine the behaviour of a system. Identifying critical linkages can help, among other things, to identify possible policy leverage points.

Tools particularly useful for identifying critical linkages are life-cycle models and integrated assessment models. An integrated assessment model was used, for example, to identify the critical linkages between dietary preferences, per capita meat consumption, food demand, cropland and rangeland area, water and other inputs to farm productivity and finally, the emissions of greenhouse gases related to agricultural land use¹. The researchers provided evidence through this set of critical linkages that greenhouse gas emissions related to agricultural land use could be significantly reduced by lowering meat preferences. This example illustrates how models can be used to analyse critical linkages in a complex nexus system, and also how this analysis can generate important policy-relevant insights.

Systems thinking can also help illuminate particular issues on the nexus of water, soil and waste. One such issue is the impact of the rebound effect on improvements in irrigation water-use efficiency. The rebound effect occurs when efficiency improvements do not achieve their intended aims because of unexpected cause and effects. In the case of irrigation water efficiency, the rebound effect could mean that efficiency actions inadvertently lead to a loss in water availability elsewhere. For example, a case study from the Kansas plains found that shifting to a more water efficient version of pivot irrigation indeed saved water from the farmer's perspective but set into motion a set of actions that ultimately reduced water availability². In this case, farmers took advantage of cost savings from efficiency improvements to shift to more water-intensive crops and/or make more frequent and extensive use of irrigation. This increased the overall irrigation water demand and accelerated depletion of groundwater sources of irrigation water. Authors of the case study suggested that restricting water allowances for irrigation could ultimately counteract the rebound effect by discouraging farmers from expanding their irrigated areas, and this would slow down the depletion of groundwater resources.

From the systems perspective, this and other case studies of the rebound effect and irrigation water-use efficiency suggest the following³:

- the rebound effect can be seen as the failure to reach the systems goal of maximizing services from water and soil, while minimizing waste
- the rebound effect occurs if critical system linkages are not taken into account especially with regards to human behaviour (e.g., farmers responding to cost savings coming from efficiency gains to invest in more irrigated crops)
- solutions can be found by examining the 'larger system', including critical linkages – in the case studies, solutions arose when the whole water resource was taken into account (groundwater aquifer or entire river basin) rather than just the immediate irrigation water use on farms

¹ Stehfest, E. et al. 2009. Climate benefits of changing diet. *Climatic Change* 95:83–102. DOI 10.1007/s10584-008-9534

² Pfeiffer, L., Lin, C. 2014. Does efficient irrigation technology lead to reduced groundwater extraction?: Empirical evidence. *Journal of Environmental Economics and Management* 67 (2), 189–208.

³ Dumont, A. et al. 2013. Is the rebound effect or Jevons paradox a useful concept for better management of water resources? Insights from the irrigation modernization process in Spain. *Aquatic Procedia* 1:4–76; Warda, F, Pulido-Velazquez, M. 2008. Water conservation in irrigation can increase water use. *PNAS* 105(47): 18215–18220

Summing up, although a general systems approach to nexus problems is not yet available, ultimately this approach is likely to have the following elements:

1. Mapping the nexus system using systems science tools, and clarifying whole systems goals
2. Quantifying system linkages
3. Identifying out of all linkages the *critical system linkages* and feedbacks that determine system behaviour and that could act as leverage points for policy
4. Identifying policy actions that achieve whole systems goals

Building on these initial ideas, systems thinking can illuminate problems and help identify solutions on the nexus of water, soil and waste.

SESSION REPORTS

S1

THE NEXUS APPROACH IN THE LIGHT OF CLIMATE CHANGE ADAPTATION AND MITIGATION

Leading Convener:

United Nations Convention to Combat Desertification (UNCCD), Sergio Zelaya

Co-Convener:

UNU-FLORES, Stephan Hülsmann

Climate change is expected to have significant impacts on the individual resources of the Water-Soil-Waste Nexus (mainly water and soil) and on their interrelations in a complex way. This session asked if and how adopting a Nexus Approach to managing water, soil and waste may help in adapting to climate change and mitigating its impacts. The five presentations given in S1 addressed this issue from different perspectives, using a variety of approaches. A key question raised was how to tackle complexity inherited in the nexus. Several examples showed that modeling tools and new technologies (e.g., remote sensing) for monitoring environmental resources (in terms of quantity and quality) are important and useful for developing integrated management approaches. Such tools enable assessing current and anticipated trade-offs (e.g., between competing water uses) and predicting the outcome of certain management strategies under global (climate) change scenarios. Sometimes the resulting intricate diagrams need to be appropriately 'translated' at the local (on-the-ground) level, especially in relation to agriculture and to the conflicting interests that integrated natural resources management may have (land tenure, public policy support, small-holder farmers, etc.).

All presentations emphasized the human perspective as the starting point. From a practical standpoint, this means stakeholder involvement (e.g., in defining scenarios and management objectives) and in particular considering livelihoods and the role of communities as stewards of ecosystem services and empowering them to manage the ecosystems sustainably via outreach and capacity development activities.

The human perspective implies focusing on strategies to cope with climate variability. The session emphasized that climate change is being felt by local communities, but that its impacts interact with other pressures on environmental resources (i.e., being only one factor promoting among other things desertification, soil erosion and declining water availability and quality). It was stressed that population growth is the main driver of the increasing demand of resources, interacting with climate change to cause supply insecurity.

Addressing the nexus is (still) an innovative approach for science-based policy development and implementation; a new approach to be considered not only at the local and national level, but also regarding international cooperation schemes and programmes. Its further development and implementation is hampered by current policies that support 'business as usual' over innovation, by weak local governance for natural resources management, by distortion among rural/urban markets and their conditions and by expected uncertainty in water and food security. During the session, reference was made on the iterative mode of the policies that address the nexus components water-soil-waste and energy. Due to conflicting interests and information availability, there are policy asymmetries regarding the mentioned components of the nexus. To advance a Nexus Approach, taking a bottom-up perspective (i.e., the view of the land users and the local community in the formulation of national strategies and policies) with regard to climate change adaptation is particularly important with respect to agricultural policies. Regarding energy security, more options and alternative resources exist.

From 2015 onwards, the Sustainable Development Goals (SDGs) will be in place. Policies and research based on the Nexus Approach could contribute to the national implementation of such goals and their targets, in accordance with national specificities. This however, requires working in an integrative manner (not in silos). Even though the session did not fully address the SDG process, by focusing on on-the-ground options, practical responses coherent with a bottom-up approach were presented and discussed.

Regarding investments for future research and policy development, linking the nexus and climate change, S1 participants shared views that the nexus components should not be treated in a parallel process to the SDGs and climate change adaptation but as part and parcel of such processes. It is up to the nexus advocates to make this connection at the policy level, based on sound scientific basis. For instance, the soil and water footprint as well as the waste footprint should be monitored with coherent tools and mechanisms, using indicators that are also related to implementing the SDGs and climate change adaptation strategies. Such indicators should contain those that identify the changing trends on resilience of populations and on ecosystem conditions; one example of the latter is trends in soil carbon stocks. Using the Nexus Approach when developing strategies to implement SDGs and adapt to climate change can ensure resource efficiency and policy coherence.

Oral Presentations

Tackling complexity in a changing climate: The Water-energy-food nexus in low income countries

Louise Karlberg (Stockholm Environment Institute)

- > The processes of agricultural transformation and energy transitions are interconnected and will require strategies to both adapt to a changing climate as well as to mitigate climate change impacts.

WebGIS-based simulation of water and nutrient fluxes in the Miyun catchment area as part of an integrated water resources management

Micha Gebel (GALF bR), Ralph Meissner (Helmholtz Centre for Environmental Research (UFZ)) and Jun Lu Bing (Beijing Soil and Water Conservation Center)

- > A bottom-up approach was used to simulate runoff, soil erosion, sediment, phosphorus and nitrogen input into the Miyun reservoir. Mitigation options to reduce sediment and nutrient loads were tested.

Aspects of natural resource use and adaptation to climate change in the Nigerian Savanna

Felix Olorunfemi (Nigerian Institute of Social and Economic Research), Mayowa Fasola (University of Lagos), Grace Olouko (Lead City University), Peter Elias (University of Lagos) and Vide Adedayo (University of Lagos)

- > Communities are well aware of the threat of extinction to some local economic tree species on which livelihoods depend and are, therefore, willing to partner with other stakeholders to improve ecosystems management and adaptation to climate change.

Global change, cattle commodification and pastoral identity in the Horn of Africa

Chanda Burrage (Pennsylvania State University)

- > Cattle herders in the Horn of Africa are experiencing a push toward expanding export markets. A commodity chain approach is used to examine the dynamics of cross-border cattle trade in the region.

Prospects of feeding more people under changing conditions of climate, land use and water resources in the Central Rift Valley, Ethiopia

Mezegebu Getnet, Martin K. van Ittersum, Huib Hengsdijk and Katrien Descheemaeker (Wageningen University)

- > This presentation examined climate change and its effects on water, land use, irrigation and crop yields.

Poster Presentations

Land, climate and resources decision support system: A model tool to support the Nexus Approach

Barbara Koestner (TU Dresden)

- > Spatial model system for agro-ecosystem analysis and climate change impact; connecting processes of soil, water and plant production; combining scenarios of climate change and agricultural economy.

Varying characteristics and influencing factors of annual runoff in watershed

Wenzhao Liu (Northwest A&F University) and Lulu Zhang (UNU-FLORES)

- > The change in runoff at catchment scale was investigated. Human activities were responsible for the decline of runoff coefficient in addition to climate change. Adaptions to climate change and watersaving management system are of significance for future development.

S2A

THE GOVERNANCE OF CLIMATE ADAPTATION: COMPARING EXPERIENCES OF DIVERSE REGIONS AND SECTORS

Leading Convener:

University of Osnabrück,
Joanne Vinke-De Kruijf

Co-Convener:

University of Twente,
Gül Özerol and Cheryl de Boer

Session 2A invited comparative studies concerning the governance of climate adaptation in different regions and sectors, with the objective of identifying what works (and what does not) in which context and why. The session consisted of a brief introduction, two short poster presentations, four regular presentations and a panel discussion. The session was a great success, providing lively discussions and insights into adaptation initiatives – or the lack thereof – by actors of the public and/or private sector in various countries and regions around the world.

Jaladdin Mirnezami addressed over-exploitation of groundwater resources and the lack of adaptation in the pistachio industry in Iran. In this case, exploitation-oriented actors with large resources consider short-term benefits only, and conservation-oriented actors take a long-term perspective, yet have limited resources.

Lisa Roodenburg investigated adaptation to annual flooding in Metro Manila, Philippines, from a multi-level governance perspective. Highly affected poor urban residents interact with community organizations to get access to influential external actors. However, there is a lack of coordination in this fragmented policy landscape.

Matteo Roggero presented a comparative study on the relation between adaptation and administrative coordination in 24 German municipalities. These cases were selected on the basis of their vulnerability to climate change. His theoretical starting-point was that more intensive coordination, while decreasing problems later on, comes at the cost of lengthier decision-making processes. Municipalities have thus the choice to organize themselves in integrative ways or choose modular forms of organization instead, saving the cost of decision-making if no problems are expected down the road. Adaptation, however, calls for integrative approaches. Evidence shows that municipalities organized in integrative ways tend to adapt within their available institutions. Most municipalities are still in the process of shaping their adaptation processes rather than actually implementing measures.



Gül Özerol presented the results of a comparative study on the governance of drought adaptation by six water authorities in five northwestern European countries. In this part of Europe, droughts are likely to occur more often in the future. A team of scientists in cooperation with relevant stakeholders applied a Governance Assessment Tool (consisting of five elements and four criteria) to identify which aspects of the governance system are restrictive/supportive of drought adaptation. The element 'actors and networks' was the most supportive (i.e., relevant actors are included and cooperate) whereas 'problem perspectives and goal ambitions' was the most restrictive (drought is not seen as a problem yet). Further research is being done to identify and compare the potential and actual transfer of knowledge across the various regions, given their diverse governance contexts.

Ethemcan Turhan gave a human face to the climate change and migration debate. He showed a picture of a Spanish golf course with migrants climbing the fence and a police agent enforcing security. The attention to migration in scholarship and policy is growing, yet there is little attention to seasonal and circular migration. Migration is seen as a threat (e.g., to security) as well as a solution or way of adapting. He highlighted that migration occurs on an individual basis without any strategic societal plan behind it. Migrants are deprived of their right to stay and adapt where they live and have no choice but to work without any form of social security. More attention needs to be given to issues such as land grabbing and migrants' destinations.

Kathrin Knüppe presented preliminary insights from a comparative study on the role of ecosystem services in water management and climate adaptation strategies in eight regions in Europe, Africa, Asia and Australia. Clear and binding institutional settings, the role and patterns of networks and multi-level governance interactions are used as indicators of transformation towards more adaptive approaches. The cases were compared using the Management and Transition Framework. While adaptation has started in all cases, the actual implementation of adaptation actions varies across cases. Technical solutions and top-down approaches by state agencies prevail, and ecosystem services are hardly considered. The governance systems are characterized by conflicts and a lack of cooperation and integration.

In the panel discussion, the presenters answered various in-depth questions from the audience and reflected upon questions related to the nexus. The following were the main conclusions of this session:

- Regions are in different stages of adaptation and also adapt in different ways (e.g., formal versus informal, business-as-usual versus systematic approach).
- Systematic comparison of governance systems can help to identify what works and what does not, however, how to best govern adaptation differs from region to region.
- Climate change adaptation is a subjective and value-laden concept. We need to move away from technical solutions and focus more on ecosystem-based approaches.
- Linking different sectors is of crucial importance when adapting to climate change. The effective implementation of a 'nexus' (or systems thinking) approach requires leadership that creates vertical linkages (across multiple governance levels to also integrate community perspectives) as well as horizontal linkages (across multiple sectors and networks). Bridging organizations or NGOs can play an important role in cases where distrust and conflict towards the government prevails.

Oral Presentations

The Role of ecosystem services in climate adaptation management

Kathrin Knüppe (University of Osnabrück)

- > The ecosystem service concept supports adaptation to climate change, as water related problems are an issue of governance failure and there is a lack of cooperation or interaction across actors, which hinders implementation of adaptation policies.

Adapting institutions: Institutional economics and segregative vs. integrative Climate Adaptation

Andreas Thiel and Matteo Roggero (Humboldt University Berlin)

- > We will compare the approaches of coordination across 14 municipalities in North Rhine-Westphalia, Germany and show that those investing in coordination in general also invest in climate adaptation.

Governance assessment of drought adaptation in Northwest Europe: A regional comparative study

Gül Özerol (University of Twente), Joanne Vinke-De Kruijf (University of Osnabrück), Cheryl de Boer (University of Twente), Alison Browne (University of Manchester), Isabelle La Jeunesse (Université de Tours), Hans Bressers (University of Twente) and Rodrigo Vidaurre (Ecologic Institute)

- > This contribution is on drought adaptation in Northwest Europe. Drought governance is assessed for six cases. The transferability of lessons is discussed by considering the contextual differences.

Beyond migration-as-adaptation: Governance challenges of temporal and circular migration schemes as a response to climate change

Ethemcan Turhan (Istanbul Policy Center, Sabanci University)

- > While migration is an important adaptation strategy, the recent surge of migration-as-adaptation in policymaking may prioritize and lead to individualization instead of collective social transformation.

Poster Presentations

Neglecting climate adaptation under the umbrella of non-adaptive water governance:

The story of transition from Qanat to pumped wells in Rafsanjan, Iran

Seyed Jalaleddin Mirnezami (Tarbiat Modares University), Ali Bagheri (Tarbiat Modares University), Cheryl de Boer (University of Twente) and Mohammad Abdollahi Ezatabadi (Pistachio Research Institute)

- > Contextual analysis, Non-adaptive water governance, Pumping technology, Climate adaptation, Technological transition, Qanat, Rafsanjan

Interactive governance of urban flooding in Metro Manila

Lisa Roodenburg (University of Amsterdam)

- > Floods are a major governance challenge in Metro Manila. Adaptation strategies are multileveled and highly institutionalized. Integration among actors and levels is lacking.

S2B

CLIMATE ADAPTATION FROM A BOTTOM-UP PERSPECTIVE: STAKEHOLDER INVOLVEMENT, PERSPECTIVES AND KNOWLEDGE

Leading Convener:

University of Osnabrück,
Joanne Vinke-De Kruijf

Co-Convener:

University of Twente,
Gül Özerol and Cheryl de Boer



Photo: R.Vigh/IOER.

As the consequences of climate change are ultimately experienced most directly at the local level, the aim of this session was to provide general insight on the integration of bottom-up perspectives and knowledge into the governance of climate adaptation. The session consisted of a brief introduction, one short presentation, four regular presentations and a panel discussion. The session successfully provided lively discussions and four international comparative studies providing insights into climate adaptation from a bottom-up perspective.

Sara Lotfi gave a short presentation of her institutional analysis of the over-exploitation of groundwater in the case of irrigation water management in Iran. Top-down approaches are failing and bottom-up approaches are needed instead, yet stakeholders are not motivated to self-organize.

Sabine Schulz presented a study asking under what conditions international River Basin Organizations (RBOs) are capable of dealing with environmental (climate and human-made) change. To answer this question, she compared adaptation capacities – with a focus on the dimensions of environmental protection and livelihood development – of two RBOs in Southern Africa. She distinguishes between nine institutional variables and presented the results for two of them: scientific data and information. The basin that is more developed (less pristine) is also more successful in adapting and shows higher levels of data sharing and, even more important, a better integration of data and information into decision-making. Stakeholder involvement is important but does not explain differences between the cases.

Gregor Vulturius presented a comparative study of climate risk perceptions and adaptive behaviour of farmers in Ghana and forest owners in Sweden. The study focused on individual behaviour and the role of cognitive and social factors, with particular attention to learning from climate science. So far, the majority of the Ghanaese farmers (ca. 80%) have not taken any adaptation actions, whereas Swedish forest owners (ca. 46%) increasingly do. Personal knowledge plays an important role and is influenced by direct experience with extreme events and by information. Scientific information about climate change, if communicated in small settings and tailored to local needs, has a positive influence on adaptation. Hence, there is an urgent need for more user-oriented science.

Jürgen Pretzsch presented a research project that he and multiple PhD students are doing in Bolivia, Peru and Ethiopia. The research is explorative and case-based with innovative socio-economic field laboratories as key research instruments allowing for participatory diagnosis and implementation. One study on livelihood strategies shows that traditional ecological knowledge is becoming less relevant when adapting to climate change and that diversification increases system resilience. Another study on agroforestry highlights that combining trees and crops involves trade-offs but increases resilience and provides more sustainable incomes. A study on communicating and transferring adaptation knowledge draws attention to issues related to the importance of face-to-face communication, access to information and gender. There is much more knowledge about adaptation than exchanged and adopted.

Caroline van Bers presented the insights of a project concerning disaster risk reduction and climate change adaptation in four hazard-prone regions around the world. The focus of the project was on capacity development rather than generating new knowledge. A think tank was established including 130 persons (working in NGOs, government, scientific organizations and private sector) from 28 countries. Members of this think tank participated in global and regional workshops as well as online meetings and discussions. The project produced four best-practice guidelines, one for each region. The project confirmed the need for intergovernmental coordination, making adaptation an integral part of policies and administrative programs, adequate legislation and enforcement, knowledge sharing and training (also of journalists!), and the need for collaborative, entrepreneurial leadership especially at the local level. It also provided examples of how these priorities are being or could be accomplished.

The session was concluded with a panel discussion during which the presenters answered questions from the audience and discussed the 'nexus' and the implementation of the SDGs. The main conclusions of the session were the following:

- The 'household' level is an important level of analysis when studying the governance of climate adaptation, since this is where important decisions are made. Communicating climate change to these households is challenging with no 'one size that fits all' approach and message. Tailoring approaches to local needs can enhance adaptation. Depending on the

sense of urgency, there may be a need for communication to raise awareness or to provide knowledge about adaptation measures.

- Interlinkages across economic sectors as well as across administrative/political levels are highly important to the governance of climate adaptation and need to be better understood. While the 'nexus' is clearly relevant, it is also a higher-level concept that does not (yet) play a central role in stakeholder communication. We should continue to be critical of what it means and contributes when dealing with climate change.
- The successful implementation of the SDGs is likely to be influenced by cultural and socio-economic factors. Implementation is a challenging process that involves multiple translations (i.e., from the global to the national, regional and local levels).
- Research in developing countries is challenging and resource-intensive. Researchers should at all times make clear that they are not coming to help but to cooperate, support and learn. As researchers are highly dependent on local networks, trust, translators and knowledge brokers, there is an urgent need for research projects with a time horizon that is longer than three years.

Oral Presentations

Environmental change and adaptation capacities of River Basin Organizations in southern Africa

Sabine Schulze (University of Leipzig)

- > The presentation examines the role international River Basin Organizations (RBOs) in southern Africa play in governing environmental changes within international watercourses in the region.

Comparing, explaining and changing perception of climate risk and adaptive behaviour in the global South and North

John Appah (West African Science Service Center on Climate Change and Adapted Land Use) and Gregor Vulturius (Stockholm Environment Institute)

- > In our presentation, we will compare findings from the Global South and North to explain why people perceive climate risks differently, and what scientists and governments can do to promote adaptation.

Local strategies to cope with climate change: Experiences from the Andean regions in Bolivia and Peru and knowledge transfer to East Africa.

Jürgen Pretzsch, André Lindner, Maxi Domke, Francois Jost and Marolyn Vidaurre (TU Dresden)

- > Based on studies from the Andes region and east Africa, climate change adaptation and the involvement of rural communities in knowledge and technology generation are discussed. Experiences with socio-economic field laboratories are presented.

Governance in support of disaster risk reduction and climate change adaptation: Insights from four hazard-prone regions

Caroline van Bers (The Integrated Assessment Society) and Matt Hare (National Autonomous University of Mexico (UNAM))

- > This presentation aims to mainstream Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) and illustrate the importance in good governance for both DRR and CCA by empowering local communities and building bottom-up governance structures with a focus on 4 different regions (South and Southeast Asia, Mediterranean Europe, East and West Africa, and Central America and the Caribbean).

Poster Presentations

Climate change and its impact on cooling in power plants

Charlotte Nowiadomsky and Ingela Tietze (Hochschule Niederrhein: University of Applied Sciences, SWKEnergiezentrum E2)

- > This study utilised survey questionnaires to assess the knowledge and understanding of students and workers in Ibadan, Oyo State about climate change risk, responses and coping strategies.

>

Paradigm shift in the irrigation water management in a changing climate

Sara Lotfi and Shahab Araghinejad (University of Tehran)

- > Qazvin Irrigation Network. Self-Organization. Climate Adaptation. Groundwater Depletion. Bad Governance.

Key stakeholders of climate change and disaster risk management: The example of flood risk management in the city of Accra, Ghana

Raphael Ane Atanga (Dresden Leibniz Graduate School) and Jochen Schanze (TU Dresden)

- > Findings from identification of key stakeholders of environmental risk management and analysis of their roles, influences and interrelations are presented for the capital of an African country.

WHAT INFORMATION ON CLIMATE CHANGE DO WE NEED TO MANAGE THE RESOURCES OF WATER, SOIL AND WASTE?

Leading Convener:
TU Dresden,
Christian Bernhofer

Co-Convener:
UNESCO Institute for Water Education (UNESCO-IHE),
Janez Susnik

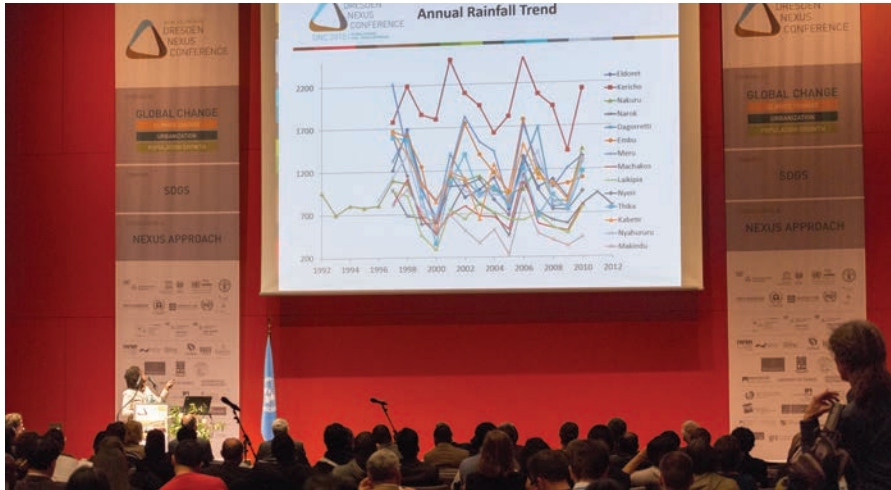


Photo: R.Vigh/IOER.

This session asked for contributions on the proper climate information necessary to manage water, soil and waste (WSW), with a special emphasis on the nexus. In total, there were six oral and ten poster presentations, emphasizing the clear interest in the topic. They addressed various nexus-relevant examples, such as, climate change parameters' relation to land-use land-cover changes in Kenya, representative climate change projections for hydrological impact studies in Brazil, the MOSAICC (FAO) system of models to evaluate the impact of climate change on agriculture or an integrated regional climate change impact assessment and evaluation methodology.

The following needs were identified to advance the WSW Nexus during the session:

- Regional scale information and relevant statistics, including extremes: It was agreed that climate variability is an already existing challenge (often occurring alongside climate change) and that ongoing and future climate change will increase climate-related risks.
- A proper treatment of uncertainties is important along modelling chains, from societal changes through climate change (global, regional and local) to adaptations (cascade of uncertainties). The uncertainty related to adaptation options can be reduced by proper treatment of vulnerability and management options.

It was highlighted that climate data and information sources need to be accessible for proper planning of nexus-related research and initiatives. This includes climate change data from global and regionally downscaled models, as well as information on model performance. The existing monitoring networks – especially climate and weather stations – are crucial for the assessment of climate variability and climate change. They can be supported, but not replaced, by remote sensing data. There is a high potential that model output data and re-analysis data can help in data scarce regions and with the comparison of different models to access model performance.

Oral Presentations

Effects of climate change parameters on land-use land-cover changes in the central region of Kenya

Mercy Mwaniki and Matthias Möller (Beuth University of Applied Sciences Berlin)

- > This presentation will analyse the land-use land cover trend, revealing aridity and loss of green land cover by using expert rules in a knowledge based Land use Land cover classification along with transformed feature space data (e.g. PC), vegetation indices, DEM and slope to form classification rules for medium spatial resolution data.

Water, energy, food modelling for long-term resource analysis: A Demonstration of concept

Janez Susnik (UNESCO-IHE)

- > This presentation illustrates the development of systems that use the water-energy-food model within a Singapore case study. The results show that future trends are strongly pathway dependant. Ways forward are also suggested.

Assessment of representative climate change projections for hydrological impact studies in Distrito Federal, Brazil

Pablo Borges, Barfus Klemens and Christian Bernhofer (TU Dresden)

- > Statistical downscaling, SDSM, ensemble, GCM, uncertainty, period change, precipitation, mean temperature, representative projections, hydrological modelling, Distrito Federal, Brazil

Bringing multidisciplinary in climate change impact assessment: An example in agriculture

Hideki Kanamaru, Francois Delobel and Oscar Rojas Hare (FAO)

- > A multidisciplinary software tool developed by FAO to generate information of climate change impacts in agriculture and called MOSAICC is presented.

An integrated regional climate change impact assessment and evaluation methodology considering multiple resources and their usability

Jochen Schanze, Axel Sauer and Marco Neubert (IOER)

- > A new methodology allows for an integrated climate change impact assessment and evaluation for the resources water, soil and others on the regional to local level to support environmental management.

The Global Land Project with an Emphasis on the Amazon

Fabiano Micheletto Scarpa and Sebastien Boillat (National Institute for Space Research (INPE))

- > The activities developed by the International project office (IPO) of the Global Land Project (GLP) based at INPE in Brazil.

Poster Presentations

Climate change projections and impacts in the West Bank, Palestine

Hadeel Qasim Sulaiman (An-Najah National University), Wafa Hamdan (An-Najah National University),

Mohammad Almasri (An-Najah National University) and Fathi Anyah (Palestine Technical University)

- > Palestine is projected to be negatively impacted by climate change. The analysis shows that the monthly mean rainfall is expected to decrease while temperature is expected to increase

How do the frequency and severity of flooding affect the livelihoods of farmers in the context of climate change?

Alice Bonou (West African Science Service Center on Climate Change Adapted Land Use [WASCAL])

- > Within the Beninese part of the Niger basin, the severity of the fluvial flooding is related to the rainfall pattern at the upstream. Further, the frequency of this flooding had a negative effect on the 2012 agricultural income of farmer.

Comparative analysis of urban climate in Chile, and its relationship with selected geographic and urban factors

Pamela Smith (University of Chile), Hugo Romero (University of Chile), Alexis Vásquez (University of Chile),

Dustyn Opazo (University of Chile) and Cristian Henriquez (Pontificia Universidad Católica de Chile)

- > The differences in the urban climate between the two cities considered in this study may be explained by regional factors such as latitude and continentality. Within each city temperatures vary spatially according to the proportion of vegetation and impervious surfaces.

Long flood time series from geoarchives: Evidences from lake and reservoir sediments

Lucas Kämpf (TU Dresden), Achim Brauer (German Research Centre for Geosciences (GFZ)), Markus Czymzik (Lund University),

Tina Swierczynski (GFZ), Frank Jacob (TU Dresden) and Karl-Heinz Feger (TU Dresden)

- > Detrital layers in varved lake sediments provide flood archives on up to millennial time scales that can be dated with seasonal precision and calibrated with instrumental flood data.

Shifting seasonality of precipitation extremes in Saxony

Andrea S. Schaller, Johannes Franke, Thomas Pluntke and Christian Bernhofer (TU Dresden)

- > Changing spatial and temporal patterns of the occurrence of precipitation extremes indicate a shifting seasonality during the summer months in Saxony.

Comprehensive observations of precipitation by means of radar – chances and challenges:

A Climatological case study for Saxony, Germany

Rico Kronenberg (TU Dresden)

- > Processing of radar-derived precipitation data needs to focus on universal applications without limitations in quality and applicability, hence portable and scale free processing is recommended.

Smart environmental monitoring using low-cost sensor networks

Pierre Karrasch, Daniel Kadner, Matthias Müller and Lars Bernard (TU Dresden)

- > Crowdsourcing, the exploitation of Citizen Science and the use of low-cost sensor technologies offer a new source of environmental data supporting sustainable management of natural resources.

Impacts of climate change on storm water system in Al Hillah City, Iraq and suggestions for the decision makers

Firas Aljanabi, Christian Bernhofer and Peter Krebs (TU Dresden)

- > A complex modelling chain was applied: GCM, weather generator, temporal downscaling and urban drainage. With increasing extreme precipitation, adaptation to climate change is necessary to avoid additional flood risk in the future.

Separating the effects of changes in land cover and climate on water resources: A Hydro-meteorological analysis for Saxony, Germany

Maik Renner (Max-Planck-Institute), Kristina Brust (TU Dresden), Kai Schwärzel (UNU-FLORES), Martin Volk (Helmholtz Centre for Environmental Research [UFZ]) and Christian Bernhofer (TU Dresden)

- > We illustrate a new method to quantify the impact of climatic and land cover changes on decadal streamflow. We apply it for 68 catchments covering the State of Saxony, Germany.

Soil hydrological properties of a tropical basin: Case of the Beninese basin of Niger River (West Africa)

Djigbo Felicien Badou (WASCAL), Bernd Diekkrüger (University of Bonn), Abel Afouda (WASCAL) and Evison Kapangaziwiri (Council of Scientific Industrial Research [CSIR])

- > In West Africa, the scarcity of soil data limits the development of physically-based hydrological models. To fill in this gap, a database of soil hydrological properties is made up for Niger River.

S4

INCLUSIVE AND SUSTAINABLE INDUSTRIAL DEVELOPMENT FOR RESOURCES EFFICIENT INDUSTRIES

Convener:

United Nations Industrial Development Organization (UNIDO), Jerome Stucki

The session's objective was to raise awareness for the challenges faced by industries in mitigating and adapting to climate change while ensuring economic growth. The three presentations contributed to this objective by providing examples of measures and actions at the global and local levels for small and medium size enterprises (SMEs) and industries.

The session illustrated that all three elements of the Water-Soil-Waste Nexus are interrelated and equally critical. It provided concrete examples of best management practices and a Nexus Approach to the sustainable management of resources and industrial development. Greening industry, jointly with infrastructure and innovation, is expected to be one of the SDGs. This highlights the need to include industry in the dialogue on global change and the Nexus Approach. SDGs can be supported by green industries by contributing to economic growth, creation of new jobs and reduction of negative environmental impacts.

The first presentation, delivered by Mr. Heinz Leuenberger, focused on industrial resource efficiency at the global level, including water and waste, with examples of pilot projects at the enterprise level. He emphasized that industry is the main driver to job creation and poverty reduction; however, current production and consumption patterns are unsustainable, and immediate action to decouple economic growth from resource depletion is needed.

Mr. Vincent Kyere presented the negative impacts of informal e-waste recycling on soil and water at the Agbogbloshie site in Accra, Ghana. High levels of contamination are directly threatening water and food security and, most importantly, the health of the population. He underlined that strengthening of policies to prevent the export of waste from one country to another is essential to reducing the flux of e-waste to developing countries.

In his presentation, Mr. Julian Meyer provided insights on how SMEs in the Dresden area can adapt to climate change. In a context where people do not feel affected by climate change, finding

the correct wording to approach enterprises was a challenge. Based on future climate scenarios, a matrix was used to show SMEs how to adapt to climate change.

Industry is responsible for a third of all CO² emissions and 20 percent of global water use; therefore, greening of industries can have a significant impact on mitigating the effects of climate change. Industries often do not feel affected by climate change until there is a flood or drought that directly impacts their activities. Though industries may not feel responsible for climate change, it is important to raise awareness within the sector regarding their role. Industries will have to adapt to climate change by using an integrated approach based on resource efficiency that will combine water, soil and waste management.

New innovative approaches are needed to change the current intensive consumption patterns of industry. One example given during the session was to have a new model for the commercialization of electronic equipment such as mobile phones. While consumers are interested in the services provided by the mobile phones they do not necessarily need the apparatus. Furthermore, mobile phone producers are currently not paying due attention to the recyclability or longevity of their devices. The idea presented was thus to lease a mobile phone instead of buying one. The mobile producer would retain ownership of the equipment and would recover the device when the customer changes mobile phone. This would incentivize producers to consider the full life-cycle of the apparatus/equipment during the designing stages, without compromising on innovation or competitiveness.

Industries and SMEs are key elements of the Water-Soil-Waste Nexus: consuming water, impacting soils directly and indirectly through resource consumption and generating wastes – a fraction of it being hazardous waste. Similarly, industries and SMEs are part of the broader water, food and energy nexus. For both nexi, the application by industries of inclusive and sustainable principles based on the greening of industries and SMEs, combined with the development of environmental technologies and environmental services providers can contribute to water, energy and food security.

Oral Presentations

Green Industry approach to support inclusive and sustainable industry

Heinz Leuenberger (UNIDO)

- > The Green Industry initiative is a sector strategy to reach a Green Economy and Green Growth through the in the manufacturing and allied industry sectors.

Spatial assessment of soil contamination from informal e-waste recycling site in Agbogbloshie, Ghana

Vincent Kyere (ZEF) and Klaus Greve (University of Bonn)

- > Results from the soil analysis from Agbogbloshie revealed measured concentrations that were significantly higher when compared with Soil Guidance Values of both the Dutch and the Canadian Environmental Standards.

Adaptation to climate change of companies: Experiences from the Dresden region

Julian Meyr and Edeletraud Guenther (TU Dresden)

- > The presentation will introduce an innovative scenario process that enables companies to think long-term and to develop appropriate adaptation strategies to climate change and other challenges.

Poster Presentations

Climate change and its impact on cooling in power plants

Charlotte Newiadomsky and Ingela Tietze (Hochschule Niederrhein: University of Applied Sciences, SWKEnergiezentrum E2)

- > Climate change causes impacts on cooling for the generation of electricity. Trade-offs between water stakeholders and alternatives for cooling will be discussed.

Mitigation policies in oil-rich jurisdictions: The Case of renewables for Alberta, Canada

Hamed Beheshti (Environmental Policy Research Center, Freie Universität Berlin)

- > Climate change mitigation policies may vary on its support to renewables in oil-rich jurisdictions.

Leading Convener:

International Hydropower Association (IHA),
Richard Taylor

Co-Convener(s):

Viet Nam Center for Technology Responding to Climate Change,
Phuong Nam Nguyen
UNU-FLORES, Stephan Hülsmann

The discussion in session S5 covered three main topics:

1. the interrelationships between agriculture and energy
2. climate aspects of renewables, including the cases of bioenergy and hydropower
3. the development of renewable energy systems

With regard to agriculture, the point was made that the cost of food is strongly linked to the cost of energy. The drive to make land agriculturally more productive tended to increase the demand for energy. More informed decision-making on land use and crop selection in relation to water and energy demand could make a significant contribution. In addition, the energy intensity of fertilisers and irrigation systems might be reduced. The capacity to model these relationships does exist, but these tools need to be refined, potentially coupled with other tools, and made more accessible.

Concerning climate mitigation, it was noted that all renewables were making an important contribution to offsetting energy production from more carbon-intensive sources. Hydropower had achieved the most certified emissions reduction through the UNFCCC Clean Development Mechanism. All energy sources and technologies will be directly or indirectly affected by climate change. In the case of the renewables family, increased atmospheric temperatures will cause changing wind patterns, cloud cover, precipitation, soil fertility and water availability. Increased temperatures will also lead to reduced soil organic matter retention over time – thus, to a climate-change induced carbon competition between bioenergy and soil organic matter replacement. Therefore, understanding climate change is fundamental to energy planning, especially on how the different technologies, with their very different operational characteristics, interact to complement each other. Four aspects might be taken in to account: climate impact/footprint, climate vulnerability, climate mitigation and climate resilience.

In the case of hydropower, it was noted that stored water would take on an even greater importance when climate change is factored in to the increasing demand for water, food and energy. The addition of climate adaptation services (drought protection and flood attenuation) may well be an additional expectation in the future, with some notable cases already in place.

The discussion on renewable energy systems focussed on two case studies from the perspective of developed and developing nations.

In the case of Iceland, all heat and power is delivered through a strong synergy between renewable sources: geothermal, hydropower and wind. It was noted that climate change was affecting Iceland through the melting of glaciers (forecast to be completely removed within 200 years), increasing temperatures, and increasing rainfall, which was considered in forward planning of investment decisions. An important consideration was the possibility to interconnect the Icelandic system with the United Kingdom; this would free up the reserve capacity (approximately 10 percent) in Iceland and bring more renewable energy into the UK system.

The second case considered was that of Ethiopia. Here the situation was typical for many developing countries, in that the demand for access to water, energy and food is a fundamental

concern. The point was made that better management of the resources would improve the situation, and all sectors were developing. For energy, there were a significant number of hydropower projects being developed, but also a realisation that other renewables needed to be brought forward. There were major potentials for geothermal and solar in particular, but these had cost barriers in relation to the hydropower resource. Efforts to attract investment were discussed. Regional interconnection, currently developed within the Eastern African Power Pool could increase the efficiencies, share risks and increase collaboration between neighbouring countries. Important news was that Ethiopia had just signed a 'memorandum of principles' with Sudan and Egypt in relation to the resources of the Blue Nile; this will create a valuable platform for further dialogue on the water, energy and food nexus in the region.

In terms of recommendations from the session discussions, the following were put forward:

- tools exist to help manage uncertainty, but these need to be improved and expanded to reflect the Nexus Approach
- access to affordable, acceptable energy underpins all human activities and is linked to our means to manage water, soil and waste in a sustainable way
- the use of waste for energy requires further priority in research and implementation
- risk and responsibilities between stakeholders and sectors need to be identified and shared equitably
- information needs to be shared more widely, including across traditional geographic boundaries and sectors
- subsidies to incentivise particular technologies should be used with extreme care, and only after cross-sectoral analysis
- governments must take the leader in recognising the need to encourage climate resilience considerations into future energy planning

Oral Presentations

Energy in Iceland: Adaptation to climate change

Oli Sveinsson (Landsvirkjun, The National Power Company of Iceland)

- > Iceland is fully renewable in both electricity and heat. Due to climate change glaciers with disappear within the next 200 years resulting in temporary increased glacial runoff.

Hydropower and climate change: Mitigating climate change and resilience in the face of uncertainty

Tracy Lane (IHA)

- > Hydropower is a renewable energy with a unique role to play in a climate constrained world. Hydropower's relationship to climate change can be viewed through four lenses: GHG footprint, mitigation, adaptation, and resilience.

A Sector modelling approach for Ethiopia's long-run investment on energy resource use option: Economic and energy supply security implication

Dawit Guta and Jan Börner (Center for Development Research, University of Bonn (ZEF))

- > This paper will evaluate potential energy development pathway and climate change related risks to power generation. Technological innovation and efficiency help cope with the risk of estimated deadweight loss.

Climate change induced carbon competition: Bioenergy versus soil organic matter reproduction – An indicator based assessment

Uwe Franko, Felix Witing, Greta Jäckel and Martin Volk (Helmholtz Centre for Environmental Research (UFZ))

- > An indicator based approach to describe the carbon competition between sustaining soil organic matter and bioenergy

Energy and food security: Role of energy models for policy planning

Alam Mondal and Claudia Ringler (International Food Policy Research Institute (IFPRI))

- > Agriculture and food security increasingly depend on energy inputs. However, there has been little analysis combining agricultural and energy models with a focus on food security. This presentation will propose thoughts for future research to jointly improve energy and food security as well as mitigate CO2 emissions.

Poster Presentations

Automation and control of biogas plants based on Linux and open-source software

Christian Etzkorn (Awite Bioenergie GmbH)

- > Experiences, products and technologies, Linux based open source software and remote assistance, training and support to overcome the lack of technology in the biogas sector in developing countries

>

Renewable energy from biogas in Vietnam: Potential and challenges for climate change mitigation

Nguyen Phuong Nam (Center for Technology Responding to Climate Change)

- > Giving the potential and challenges of renewable energy from biogas in developing countries as a practical measure to reduce GHG emissions for climate change mitigation.

CONCLUDING TALK OF THE DAY

Rabi Mohtar

Texas A&M University, College Station,
TEES Endowed Professor



On the first day of the Dresden Nexus Conference, climate change was the uniting topic of all sessions. Global changes, specifically regarding the effects of climate on water resources, are simply put into context through the phrase 'wet regions will get wetter, while dry will get dryer'. There is a significant interaction between soil moisture and surface water, which is associated with securities for both water and food. Other global changes are the loss of arable land to either degradation or land-use changes and salinity effects. Factors such as the rise of sea level, the use of fertilizer, the reuse of water and the poor management of land also contribute to global changes that will have a severe effect on projected climate changes and the consequent impact on agriculture.

Climate change projections are significant. It is predicted that there will be more intense, frequent and longer heat waves; a decrease in subtropical precipitation; an increase in precipitation intensity with longer periods between rain events; a drying of mid-continent in summer leading to greater risk of droughts; an increase in hurricane peak wind intensities and the number of most intense hurricanes; an increase in wind intensities and in the number of most intense storms. These projections will have substantial manifestations in agriculture, leading to greater crop water needs, greater city water needs, less fresh surface water in some locations, more water with infrequent events (floods/droughts), more pests and diseases, less crop cover (erosion risk), northward crop migrations, diminished water quality and more expensive energy. These projections and manifestations are just a few examples of what can occur due to climate change.

A systems theory is useful when applying the Nexus Approach to issues of climate change, because the Nexus Approach provides both tools and visualization to aid policy planning. There is a rebound effect in which efficiency improvements sometimes do not achieve the stated aim of those improvements. Many examples from the Water-Soil-Waste Nexus, specifically for the improvement of water use and efficiency of irrigation, demonstrate the need to keep the systems goal in mind. Additional important elements in enabling lasting change are nexus governance strategies, gaps in data and tools, along with the importance of communication and engagement of stakeholders. Policy, role of pricing and scaling issues are also important factors when utilizing the Nexus Approach. The private sector is a major stakeholder that needs to be engaged in implementation of nexus-oriented strategies; its role is often missed or overlooked.

A new method that can make tremendous change is the localization of water and food security through the better understanding of green water. 'New' water is another innovative resource for this method. With these new methods come research gaps, which need to be considered in order for the localization of resources to occur. Many gaps have been identified when using the systems theory in the Nexus Approach, however three stand out. One gap illustrates lack of recognition and characterization of soil as an organized physical medium, which provides the physical conditions for life and development of the numerous biotic and abiotic processes inside the soil medium. A second gap states that a quantification of the soil natural organization/structure is needed in order to have measurable (physical) parameters that provide a description of the interactions within the soil-water system. And the third is to adapt the natural multi-scale organization for processes scaling. A portfolio of nexus solutions result in the basis of nexus scenarios, which need to be assessed so that trade-offs can be established. Such trade-off analysis can be the basis of multi-stakeholder dialogues.

Upon conclusion of Day 1 of the Dresden Nexus Conference 2015, there still exists a drastic need for alterations to be made in relation to the use of the Nexus Approach for addressing the global issue of climate change. Since there is a tremendous impact on water, energy and food security by the changing climate, further adaptation measures must be bold and new models are needed to deliver better results and projections. The Nexus Approach, which is based on holistic systems theory, is needed to help identify hotspots in the nexus, since one sector does not dominate sustainability. Also, economic growth needs to be decoupled from resource consumption. Localizing water and food security through regional integrations can create more resilience to climate adaptation along with the use of 'new' water to bridge the water gap. Accounting for soil and water processes, modeling and mapping, and data and uncertainty is critical to water and food security. The energy sector is critical for the Nexus Approach, especially renewables for water, food and energy access. Lastly, the nexus and SDGs need to be brought to the human level in order to make lasting changes, and the role of diplomacy in nexus implementation must not be ignored.

PANEL DISCUSSION

Moderator	János Bogardi, Center for Development Research, Senior Fellow
Panelists	<p>H.E. Mohamed Abdelhamid Ibrahim Higazy, Egypt Embassy of the Arab Republic of Egypt to the Federal Republic of Germany, Ambassador</p> <p>Abraha Adugna Ashenafi, Ethiopia The Government of National Regional State of Tigray Water Resource Bureau, Deputy Bureau Head & Process and Owner of Irrigation Core Process</p>
	Lead Conveners from S1, S2, S3, S4 & S5

DAY 2: URBANIZATION

KEYNOTE SPEECHES



URBANIZATION: A THREAT OR AN OPPORTUNITY? WATER AND WASTE NEXUS APPROACH

Saeed Nairizi

International Commission on Irrigation and Drainage,
President



Urbanization is a population shift from rural to urban areas and the way in which society adapts to the change. The growing world population exacerbates the urbanization process to the extent that the urban population increases from 50% of the global population at the present to 70% by the year 2050. The driving force of such transformation is the unbalanced pattern in economic growth occurring mainly in developing countries, where rural communities are unable to generate sufficient income to support their livelihood, particularly to cope with the population expansion in these regions. World agricultural production accounts for less than 3% of the global GDP, where it is estimated that within the next 10 years the 2000 world megacities will contribute about 75% to global GDP. Since cities have the upper hand when it comes to capital investment, industrial activities and job opportunities, migration of rural inhabitants to cities is an inevitable phenomenon and expected to be intensified in the future. Consequently, it is reported that the absolute number of rural population worldwide has reached its maximum level and will begin to decline from now on, and urban population will sharply increase accordingly.

There are many concerns about the increase in water demand due to the expansion of urbanization and the environmental and health hazards associated with waste generated in the cities. However, in a general situation where irrigated land is converted to an urban area, the water demand demonstrates no significant changes. This is due to the fact that irrigation water requirements for a given area are almost equivalent to the municipal water consumption in the same area given an average population density. It is also important to note that an integrated approach to water supply and wastewater management within urban regions would provide opportunities to recover up to

80% of consumed water through wastewater reuse, whereas in an irrigated land the returned water may account for only 20% to 30% of applied water. Therefore, it could be stated that the national or even regional urban demand for water is not a strong opponent to the agriculture sector.

In a case study in the city of Mashhad in Iran, the treated wastewater has been programmed to replace partially the municipal water demand. Through this holistic approach, the urban water demand is categorized by the required quality, and treated wastewater should meet these requirements. Through this programme, 20% of the recovered water is allocated to the city parks and green area, 20% to the local industry and 60% (the remaining effluent) is considered for urban agriculture. The concept of urban agriculture development shows very promising socio-economic advantages. The high reliability on the availability of treated urban wastewater and access to the market for agricultural products would provide opportunities for high-value cash-crop production in the vicinities of cities. Hence, the revenue and job creation in this regard would compensate by far the probable crop production decrease due to the reallocation of water resources from agricultural to urban use.

However, attention should be focused on the water and wastewater Nexus Approach within the urban and pre-urban area – from water supply plan to wastewater management and reuse as well as from standardization to environmental and health monitoring issues. Adopting appropriate technology for decentralized wastewater treatment plants scattered within the urban region is a key to the success. Indicators and practical approaches for the safe use of treated wastewater should be carefully selected, setting reasonable standards upon the mode of consumption (e.g., if it is used for green parks or urban agriculture or indeed for ground water recharge). The attention to the socio-economic sphere is the most important consideration in this regard.

There are other issues associated with urbanization developments that need more consideration. The rural population migration to the cities is mainly due to the socio-economic conditions governing their livelihood and ambitions to seek a better life, which they cannot experience in the rural communities. They try to make their dreams a reality by indulging themselves in the activities of a nearby town or city. However, if they are not welcome by unprepared nearby cities, they will not go to the next nearest city. Rather, they take a big step towards the biggest market they perceive – the large cities. This is the main process of megacities' formation with all their associated problems.

To avoid such a dilemma, attention should be given to the development of small and medium sized cities to accommodate the rural migrants close to their homeland. Investments in employment opportunities, health and education services are examples of such considerations. This decentralized urban development strategy would divert the negative impacts of megacities' formation, particularly in developing countries, to an engine for national growth, poverty alleviation and human resources development.

Recommendations

It can be concluded that urbanization per se is not a threat, but urban population Governance that needs attention. The following recommendations would augment this conclusion:

- urbanization is a national and local strategy for any socio-economic development plan
- water-energy-waste Nexus Approach is the main pillar for a successful transformation of neighbouring rural communities to a developed urban region

- wastewater collection networks and treatment plants should be designed as decentralised schemes to allow the treated wastewater to be used locally with minimum energy requirements for pumping up
- standardisation and monitoring of the wastewater effluent quality is an essential practice, however, the considered standards should be reasonably achievable

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IS URBAN SUSTAINABILITY POSSIBLE? BIOPHYSICAL AND POLITICAL CONSIDERATIONS

William Rees
University of British Columbia,
Professor Emeritus



My starting premise is that 'unsustainability' is an inevitable emergent property of the systemic interaction between urban-industrial society, as presently conceived, and the ecosphere. The values and models driving contemporary capitalist neoliberal economies are incompatible with the structure and function of ecosystems and even the real economy. Humanity's natural expansionist tendencies (e.g., the potential for geometric increase) are being reinforced by a cultural narrative based on perpetual economic growth and endless technological progress on a finite planet.

A sustainable society can be understood as one that maintains adequate constant (or growing) stocks of human, manufactured and natural capital, maintained in separate accounts. Such

income-producing capital constitutes society's real wealth. With this in mind, economist Sir John Hicks' defined sustainable income as: 'That level of consumption that can be enjoyed from one accounting period to the next without reducing wealth'. Corollary, no society is sustainable if its maintenance and growth are being financed by the consumptive depletion of its capital, especially essential, non-substitutable forms of natural capital.

By this 'constant capital stocks' criterion, techno-industrial society is radically unsustainable. Enabled by technologies based on abundant, cheap fossil fuels, the human enterprise has expanded geometrically since early 19th Century. From a base of about one billion in 1880, the population stands at 7.3 billion today and energy/material consumption has increased much faster than population. Ironically, the continuous growth that contemporary society takes to be the norm describes the single most anomalous period in human history.

The result on a finite planet is inevitable. The human enterprise is in a state of overshoot in which demand for nature's goods and services outstrips supply. There are only 12 billion hectares of productive land and water ecosystems on Earth but humanity's effective 'ecological footprint' is nineteen billion hectares. (It would take 1.5+ years for Earth to regenerate the renewable resources humans currently use each year.) We make up the difference between sustainable (Hicksian) consumption and actual consumption – humanity's ecological deficit – by liquidating natural capital.

Now consider cities. We usually think of cities as areas dominated by the 'built environment' and characterized by high population densities. They are hotbeds of artistic, cultural and political activity and regarded as 'engines of national economic growth' (Jane Jacobs). All this is true, but we forget that cities are also complex biophysical systems, systems subject to natural law.

Under the second law of thermodynamics cities are dissipative structures, open systems that can maintain themselves and grow only by consuming and degrading available energy/matter extracted from their host environments (ecosystems) and by 'dissipating' the resultant waste back into their environments. In short, cities maintain their internal 'order' (negentropy) at the expense of increasing the external 'disorder' (entropy) of the ecosphere.

Seen this way, the city is a node of intense energy and material consumption and waste generation dependent on a complementary, vastly larger area of productive ecosystem that lies mostly outside the city. The city's de facto ecological footprint is typically several hundred times larger than its geographic area.

It follows that cities are highly vulnerable to global change. Entropic degradation and climate change threaten food, water and other resource supplies; consequent geopolitical tension and civil strife would undermine social order. A projected increase of urban populations by 2.5 billion by mid-century (equivalent to the entire human population in 1950) exacerbates the problem.

All things considered, the human enterprise may actually be forced to contract in coming decades. As an intelligent species capable of foresight and evidence-based planning, we can choose between:

- Business as usual, risking a chaotic implosion imposed by nature followed by geopolitical turmoil and resource wars or:
- A well-planned, orderly and cooperative descent toward a socially just sustainability for all.

Unprecedented levels of cooperation at all spatial scales are an obvious key to success – sustainability is a collective problem that demands collective solutions. (No city or country can achieve sustainability

on its own.) In this light, a Nexus Approach to sustainability would strive toward a smaller, materially efficient, more equitable 'steady-state' global economy that could function indefinitely within the means of nature. Since an equitable share of Earth's biocapacity (a 'fair Earth-share') is 1.7 global average hectares (gha) and the per capita eco-footprints of residents of high-income cities is typically five to seven gha, such cities should be planning for a 65–75% reduction in energy-material throughput.

This is not merely an academic target. 'One-planet living' is an absolute requirement on our single Earth. Achieving it is technically possible, socially desirable and ecologically necessary but will require rethinking the 'good life', adjustments to consumer life-styles and national/global population reduction strategies.

Problem: This is a world in denial. The fact is that: 'The masses have never thirsted after truth. They turn aside from evidence that is not to their taste, preferring to deify error...' (Gustave le Bon 1896). To make matters worse, the corporate right has socially engineered current generations to reject science and ignore reality in defense of the status quo. We have entered a new 'age of unreason'.

Governance is profoundly affected. Indeed:

'self deception ... plays a remarkably large role in government. It consists in assessing a situation in terms of preconceived fixed notions [i.e., ideology] while ignoring any contrary signs. It is acting according to wish while not allowing oneself to be deflected by the facts' (Tuchman 1984).

As a result, globally, it is still 'business as usual'. The world is on course for collapse — ecological implosion, resource wars, civil insurrection and geopolitical chaos.

And it wouldn't be the first time: 'what is perhaps most intriguing in the evolution of human societies is the regularity with which the pattern of increasing complexity is interrupted by collapse' (Tainter 1995). The modern tragedy is that the world community could, in theory, break from this pattern but as yet shows no signs of getting serious about sustainability.

Can Nexus thinking wake this world of sleep-walkers?

SESSION REPORTS

S6A/B

ECO-CITIES:

URBAN ENVIRONMENTAL DEVELOPMENT AND THE NEXUS APPROACH

Leading Convener:

IOER,
Bernhard Müller

Co-Convener:

University of Westminster, Leverhulme International Network on Eco-cities,
Simon Joss

This session set out to illustrate and bring into question current thinking about how best to go about promoting sustainable urban development. It did so, first, by elucidating key conceptual and political drivers behind recent innovations in variously labelled 'eco-city' and 'sustainable city' initiatives and projects from around the world; and, second, by evaluating practical experience through a series of empirical case studies. Central to the collective discussion was how integration



and coordination have come to play an increasingly important role in sustainable urbanism, as evidenced by an emergent focus on: (1) inter-connecting multiple sustainable development dimensions; (2) relating these to differing urban scales and (3) achieving improved alignment with policy and governance processes. Nexus thinking, therefore, goes to the very heart of current efforts on sustainable urban development.

And yet, as the various case studies reported amply demonstrated, there is often still a considerable gap between the normative ideal of a 'whole-system' approach to the sustainable city, and its translation into policy and practice. As it was reported for example from Bogotá (Colombia), the social and political framework conditions may constitute strong impediments to modern planning and sustainable development approaches. The gap between the ideal and its translation into practice is due to several concurrent boundary issues: for example, in spatial terms, achieving integrated sustainable development at effective scale may be hampered by pre-existing urban configurations and constraints; likewise, longstanding jurisdictional boundaries may impede planning and policy coordination beyond 'silos'; and equally, the need for long-term development trajectories may be undermined by comparatively short-lived electoral and policy cycles.

These and other boundary issues should not be read as making it impossible to achieve coordinated planning and integration, but they do at least underline the importance of paying attention to governance structures and processes. As such, they point to what may be considered as something of a governance deficit frequently found at work in sustainable urban development initiatives. This deficit may be especially pronounced in contexts, where there is limited existing governance capacity and practice experience – that is, not least in developing countries where urbanization is particularly in the forefront. Hence, attending to matters of governance capacity building has added urgency in these contexts.

In recent years, efforts have been underway to come up with replicable frameworks for designing, planning, assessing and certifying eco-city initiatives of one kind or another. Some of these frameworks, such as the Reference Frameworks for European Sustainable Cities (RFSC), were reported at the conference, and are subject of an ongoing international research network, Tomorrow's

City Today (<http://www.westminster.ac.uk/ecocities/projects/leverhulme-international-indicators>), in which the session chair and co-chair are both involved. While these frameworks are not without their own challenges and do not provide a panacea for effective sustainable urban development, they nevertheless point to possible conceptual and practical ways of integrating a Nexus Approach to urban sustainability. Their emergent practice experience provide essential policy lessons, not least that developing a Nexus Approach to sustainable urbanism is not merely a technical issue, but one which requires considerable governance innovation and capacity building and which, moreover, calls for close attention to be paid to the particular local settings and conditions in which eco-city initiatives are expected to flourish.

All in all, the session fully achieved its objectives. It underlined the wide variety of different approaches worldwide, and the difficulties of comparison. It clearly proved that the Nexus Approach is very useful for conceptualizing sustainable urban development and eco-city models. However, the session also made it clear that nexus thinking finds its limitations in the implementation of urban development concepts, even in those which are explicitly oriented towards sustainable urban development. Thus inter- and transdisciplinary research, especially on governance issues of sustainable urban development should be strengthened. Such research should incorporate researchers from academia as well as representatives from the urban practice.

Oral Presentations

Bogota towards a sustainable and inclusive city

Gerardo Ardila (Secretario Distrital de Planeación de Bogotá)

- > Bogotá advances towards an inclusive and sustainable city, adapting to climate change and mitigating its effects, while adopting a comprehensive approach for water, soil and waste management.

The Resource-sensitive city of the 21st Century

Janez Susnik and Michael Hammond (UNESCO - Institute for Water Education (UNESCO-IHE)), Christopher Hutton (University of Bristol), David Grey and Dragan Savic (University of Exeter)

- > A 30% water use reduction on a global scale could save USD 2 trillion within one year. Urban water demand trajectories are unsustainable. Water provision and economic development linked. Transformational leapfrogging is required.

Building eco-town framework in the municipality of San Vicente, Philippines

Hoon Chang and Heon Seok Yoo (Korea Environment Institute (KEII))

- > Climate changes at coastal cities, particularly in developing countries, bring in larger burden, yet local residents are not fully aware of its impacts. Through a well-structured framework, eco-town development will achieve sustainability on a local regional or larger level.

Smart urban planning: Implementing environmental development into urban realities

Stefanie Rössler, Bernhard Müller and Clemens Deilmann (IOER)

- > Smart solutions and approaches of urban planning play a crucial role in addressing future global environmental challenges.

Indicator based assessment of sustainability of ecosystems of eco-cities: General approaches and the example study

Solar-City Linz-Pichling, Austria

Juergen Breuste (Paris Lodron University Salzburg)

- > An indicator based assessment methodology of sustainability of ecosystems of eco-cities was implemented in the Austria eco-city Solar City Linz-Pichling.

Land recycling: Beyond land-use impacts

Geertlui Louwagie (European Environment Agency), Jordi Boronat (MediTerra) and Rastislav Stanik (European Environment Agency)

- > European land use is unsustainable. Applying lifecycle-thinking approaches to brown- and green-field developments across all stages aims at higher resource efficiency and lower environmental impacts.

Data envelopment analysis: A heuristic tool to detect ecological and economic efficiency

Clemens Deilmann, Iris Lehmann and Daniel Reissmann (IOER)

- > DEA proved to be a powerful heuristic tool to examine cities. Medium sized cities tend to be most efficient in an ecological and economic perspective in contradiction to the general assumption of economies of scale.

Resilience engineering and policy transfer: Enschede's green roof policy process

Cheryl de Boer and Mirjana Jovanovic (University of Twente)

- > Green roofs support various urban sustainability goals. Successful implementation of policies supporting green roofs depends on adapting them to a city's governance, social and technical context.

Poster Presentations

A Comparative study on the eco-city practices in Ma'anshan and Freiburg

Xiaoping Xie, Hendrik Herold and Wei Hou (IOER)

- > Using remote sensing data for quantitative evaluation of the political promises (planning) and the practical achievements (implementation) of eco-city initiatives in German and Chinese contexts.

Walking the tightrope: The challenge of sustainability for the City of Isfahan

Ehsan Tavakoli-Nabavi (Australian National University)

- > The idea of Navigational Indicators is proposed. Water-Land-Economy nexus is systematically explored. For modelling, a system dynamics approach is adopted. Water-transfer is not a sustainable solution.

Owerri Municipality, Nigeria: An eco-municipality or a mere rain-municipality

Emmanuella Onyenechere (Imo State University)

- > This study hopes to empirically investigate the situation in Owerri municipality in Nigeria to ascertain the specific challenges it is faced with in terms of employing the Nexus Approach.

The Low Carbon Development Strategy of the Great Metropolitan Area of San José, Costa Rica

Mauricio Zaballa Romero (UNEP DTU Partnership), Huberth Mendez (Fundación para el Desarrollo Urbanom (FUDEU)), Manuel Salas (FUDEU) and Irene Campos (Instituto Costarricense del Cemento y del Concreto)

- > The low carbon development strategy of the Great Metropolitan Area of San José in Costa Rica aims to encompass the needs of the urban growth with the reduction of greenhouse gases and the increase of resilience.

Policy recommendations for the solid waste management in Kazakhstan

Zhanna Kapsalyamova (Economic Research Institute (ERI)) and Artem Korzhenevych (IOER)

- > Evaluated scenarios show large greenhouse gas saving potential and positive welfare impact of the suggested solid waste management schemes in the large cities of Kazakhstan.

S7

URBAN ECOSYSTEM SERVICES AND BIOLOGICAL DIVERSITY

Leading Convener:

Federal Nature Conservation Agency (BfN),
Matthias Herbert

Co-Conveners:

IOER, Wolfgang Wende¹, Juliane Mathey and Andreas Otto; TU Dresden,
Luis Inostroza; Paris Lodron University Salzburg, Jürgen Breuste and Martina
Artmann; Centre for Development Research (ZEF), Christine Fürst;
Opole University of Technology, Marcin Spyra

Urban systems are known to be the areas with greatest conflicts over land resources and services requested by a multitude of different actors. Particularly, in densely settled metropolitan areas, requests for sustainable development and restoration of structures closer to nature are increasing. For example, urban green systems as an expression of a nexus between urban biodiversity and urban ecosystem services concerning water, soil and built-up structures are assigned a crucial role by local decision makers in influencing the quality of life of the urban population. As one major outcome of the session the following can be stated: Urban green infrastructure seems to be a world-wide key issue for offering biodiversity and ecosystem services. The session provided us with comparable country approaches on how to establish urban green infrastructure for preserving biodiversity and ecosystem services, for example, from Chile, Mozambique, Germany or Singapore. The following take-home messages can be derived from the session:

- **Green infrastructure not only addresses the nexus, but itself represents a kind of nexus.**

Green infrastructure follows the idea of connecting core habitats and/or green spaces and deals with setting up a 'corridor network' for exchange and migration. Thus, it serves to interlink valuable components and therefore can be seen as a kind of structural nexus. Also, biotic components of soil

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and water are responsible for ecosystem services like providing potable water etc. It is the biotic (e.g., microbiological) component that is responsible for water filtration and cleaning in the soil; thus, again the nexus between soil and water. And 'green' also addresses the food/energy nexus between soil and water, which is an important component of new urban agriculture concepts.

- **Green infrastructure is an important supplement to blue and grey infrastructure.**

To stress the value of urban green and open space issues within urban development, they have to be considered as important as grey or blue infrastructure. Although one might get confused with all the terminology, green infrastructure still seems to be a rather good concept to exhibit this equal value of urban green. For a common understanding of urban green infrastructure among the various relevant stakeholders it is necessary to concretize the general definition, its components and instruments for implementation on national, regional and local level.

- **Green infrastructure not only addresses linear structures, but also takes the surrounding areas and greater habitats/open spaces into account.**

In a first step one might think of an ecological network, but it is more. It is a combination of a network, core habitats as something like junctions and points of intersection, as well as biodiversity and ecosystem services within certain meshes and it reaches even beyond the borders of a city. It not only comprises well-designed parks but also incorporates urban brownfields, vertical green like roof greening as well as secondary near-natural structures.

Focus should be put on the cultural ecosystem services, particularly in the urban context.

- **Urban biodiversity and ecosystem services should be linked to the sustainability goals concept.**

We need strategic goals for urban biodiversity and ecosystem services, action plans for implementation and indicators for monitoring. For this purpose there are helpful recommendations in the CBD plan of action on subnational governments, cities and other local authorities for biodiversity (2011-2020) which was adopted by the Conference of the Parties in 2010 in Nagoya. However, cities should derive their own green strategies and set up their own goals, as local conditions are very different around the world and only this motivates them to try to achieve these goals.

Recommended Reading

Costanza, R.; Kubiszewski, I. 2015. *A Nexus Approach to urban and regional planning using the four capital model of ecological economics*. DNC2015 Position Paper. UNU-FLORES, Dresden. <https://flores.unu.edu/wp-content/uploads/2015/02/D-2-Costanza-Summary-Bio.pdf> (last access: 31st of March 2015).

Federal Government of Germany (2007): *National strategy on biological diversity*. Bonn.

Mathey, J.; Röbber, S.; Banse, J.; Lehmann, I. 'Bräuer, A. (forthcoming): Brownfields as an element of green infrastructure for implementing ecosystem services into urban areas.' *Journal of Urban Planning and Development*. Special Issue 'Green Infrastructure for Urban Sustainability'.

Spyra, M. 2014. 'Ecosystem services and border regions – Case study from Czech-Polish borderland.' *Journal of Land Use, Mobility and Environment*. Special Issue: Eighth International Conference INPUT Smart City - Planning for Energy, Transportation and Sustainability of the Urban System, p. 921-32

Oral Presentations

Multifunctional green infrastructure as a planning strategy for territorial cohesion in Santiago de Chile

Alexis Vásquez, Francisca Morales, Josefa Vergara, Andrés Riveros and Benjamín Ludeña (University of Chile)

- > Linear green infrastructure providing multiple ecosystem services challenges the high sectorial and spatial fragmentation in Santiago. On the local scale, ecosystem services present complex trade-offs across space.

A Land cover-based ecosystem services approach: A concept for integrated water and environmental resources management and sustainable urban development in Beira, Mozambique

António Dos Anjos Luís (Catholic University of Mozambique - Geographical Information Cente [UCM-CIG]), Sérgio Niquisse (UCM-CIG), Dennis Eucker (UCM-CIG), Mari Ito (UNU-FLORES), Wolfgang Wende, Karsten Grunewald, Ralf-Uwe Syrbe, Ulrich Walz (IOER) and Samuel Kusangaya (University of Kwazulu-Natal)

- > The presentation shows the concept of a simple ecosystem services approach for land characteristics in Beira, Mozambique, which take population growth, urbanization and climate change, for integrated environmental management into consideration.

Ecosystem services and biological diversity in urban areas: Challenges from the perspective of nature conservation

Matthias Herbert and Alice Schröder (BfN, Germany)

- > The presentation gives an overview of the challenges for nature conservation and maintaining of biological diversity in urban areas.

Indicators for cultural ecosystem services in urban contexts: A critical review for urban planning

Luis Inostroza (TUD), Daniele La Rosa (University of Catania) and Marcin Spyra (Opole University of Technology)

- > This presentation reviews indicators for Cultural Ecosystem Services (CES) for urban contexts. No CES indicator was found to be of high relevance to urban contexts, but there was a high dependence of indicators from data quality and availability.

Assessment of ecosystem services for urban resilience in Singapore

Jeannette Sieber and Manon Pons (European Institute for Energy Research)

- > An integrated assessment of Ecosystem Services (ES) in Singapore allows for a qualitative evaluation and localization of important ES and quantitative information on sustainability indicators.

Poster Presentations

Temperature mitigation in residential areas by urban green spaces

Madhumitha Jaganmohan, Sonja Knapp, Carsten Buchmann and Nina Schwarz (Helmholtz Centre for Environmental Research (UFZ))

- > Certain green spaces are found to be cooler than nearby urban areas and their cooling effect extends into the surrounding. This helps in mitigating heat stress in the nearby residential areas.

Ecosystem services outside of urban green areas?

Carola Meß and Harald Zepp (Ruhr-Universität Bochum)

- > Mapping biophysical characteristics of urban landscapes together with model based interpretations forms the basis for assessing, evaluating and communicating ecosystem services and of disservices.

Assessment of ecosystem services for urban resilience in Singapore

Jeannette Sieber and Manon Pons (European Institute for Energy Research)

- > An integrated assessment of Ecosystem Services (ES) in Singapore allows for a qualitative evaluation and localization of important ES and quantitative information on sustainability indicators.

Green infrastructure and ecosystem services to tackle climate change in Chilean cities

Alexis Vásquez, Natalia Gómez, Dustyn Opazo, Christian Silva and Dayán Martín (University of Chile)

- > The development and conservation of an essential network of green spaces intended for climate change adaptation and mitigation would render highly effective and efficient results. However, in Chile this approach faces a variety of barriers.

The Role of urban green spaces for cities under climate change

Juliane Mathey (IOER)

- > This poster will introduce an approach for analyzing ecosystem services based on vegetation structures. Microclimatic effects are quantified by modelling.

The Evaluations and analysis of recreation ecosystem services in urban parks of Shanghai affected by physical age and policy changing

Liang Zhao (TU Dresden), Jürgen Breuste (Paris Lodron University of Salzburg) and Wolfgang Wende (IOER)

- > Six urban parks in Shanghai were researched through vegetation mapping and field work investigation. Recreation ecosystem services were analysed within factors of physical age and policy changing.

Leading Convener:

UNESCO International Hydrological Programme (UNESCO-IHP),
Sarantuyaa Zandaryaa¹

Co-Convener:

TU Dresden,
Björn Helm

One of the major challenges for post-2015 sustainable development is providing safe drinking water and sanitation for all. To provide safe water and sanitation for the growing urban population, water resources in urban areas are under pressure for both quality and availability, as the world's population has become predominantly urban and continues to grow rapidly. Consequently, meeting the rising demand for good quality water for ever-bigger urban populations is a serious concern for many cities.

Urban water problems are complex, multifaceted and interlinked. These include lack of access to safe water and sanitation; poor, or inexistent, wastewater management; inadequate, poorly-maintained and aging water infrastructure; urban water pollution; deterioration of urban aquatic ecosystems; and the vulnerability of urban water systems to climate change impacts. The concept of Integrated Urban Water Management (IUWM) aims to optimize the whole urban water system and address these problems through an integrated approach, taking into consideration hydrological, environmental, socioeconomic and institutional aspects of water resources management in urban areas. However, a much deeper understanding of the interfaces and interconnections between the different resources streams in cities is required to improve the IUWM approach.

A nexus-based approach offers a better understanding of the complexities and dynamics to manage water and other resources across different sectors in urban areas. The session discussed how nexus-based approaches can improve urban water management in response to growing global and climate change impacts. The key message emanating from the session discussions highlighted that: **Strengthening the water-waste-energy nexus in urban areas is of key importance for sustainable management of water, energy and other resources in cities of the future.**

The session also provided experiences of integrated, holistic resources management, such as, water, waste and energy in an urban context in Kenya, China, Bolivia, Greece, and India. These experiences clearly emphasize the importance of the Nexus Approach for enhanced water security and the post-2015 sustainable development in cities.

The future of urban water management needs a *systems thinking*. *Systems thinking* is of particular importance in addressing the urban sanitation challenge and linking sanitation and wastewater management. There are novel sanitation system solutions based on a *sanitation systems thinking* that incorporate resource recovery of water, nutrients and energy. A *systems thinking* of urban water management also offers solutions with more decentralization and less urban water infrastructure requirements.

There will be no sustainable urban water management without adequate urban planning. Aging and poorly-maintained infrastructure is a major problem in developed cities, whereas cities in developing countries struggle with huge investment needs to build and expand urban water infrastructures. There is a need to focus on modern asset management planning approaches. Adequate planning is essential in ensuring the sustainability and long-term operation,

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maintenance and renewal of urban water infrastructure. Hence, water should be incorporated in urban planning and needs attention from urban planners.

Wastewater is not a waste, but a resource. As natural freshwater resources are limited and insufficient to meet the growing demand, water reuse and resource recovery from wastewater need to be incorporated as an integral part of water resources management. Many valuable resources can be recovered from wastewater, such as, water, energy and nutrients. In addition to producing energy and water for irrigation and other suitable uses, water reuse offers energy savings. Recycling of wastewater, storm water and rainwater can be less energy intensive. Furthermore, water use efficiency is essential in reducing the energy use and carbon footprint of the water sector, because saving water saves energy.

Resource recovery requires new integrated infrastructure solutions. Resource recovery not only provides integrated solutions to water, wastewater, solid waste and energy, but also requires adaptable and flexible infrastructures, adjustable to local conditions and different scales. Thus, water reuse and resource recovery from wastewater foster decentralization. On the other hand, decentralized 'smaller' infrastructures are more flexible and less vulnerable to natural hazards. Hence, future water and sanitation infrastructures need to be more diverse, flexible and adaptable to changing conditions.

Sustainable urban water management requires better coordination across different sectors and institutions. In order to ensure water security for cities of the future, coherent policies and better coordination across different sectors and institutions are needed. The Nexus Approach requires a shift towards comprehensive and coherent policies on resources management across different sectors and actors. For example, effective urban stream management and solid waste management practices such as removing the manmade debris from urban streams and maintaining the riverbed clean from urban waste can contribute to better flood management strategies in the face of increasingly-evident climate change impacts.

The 'Cities of the Future' will differ from those of yesterday and today. The Nexus Approach offers integrated and holistic solutions to address complex urban water challenges, as well as provides a framework for coherent policies towards sustainable management of water and other valuable resources, such as, energy, food and infrastructure in the cities of today and the future.

Recommended Reading

Hering, J. G.; Waite T. D.; Luthy, R. G.; Drewes, J. E. and Sedlak, D. L. (2013). 'A Changing Framework for Urban Water Systems', *Environ. Sci. Technol.*, 47, 10721–10726.

Li, E.; Endter-Wada, J.; and Li, S. (2015). 'Linkages between water challenges and land use planning in megacities', *Water Resources IMPACT*, 17 (1), 9–12.

Mo, W. and Zhang, Q. (2013). 'Energy–nutrients–water nexus: Integrated resource recovery in municipal wastewater treatment plants', *Journal of Environmental Management*, 127, 255–267

Schuetze, T.; Lee, J. W. and Lee, T. G. (2013). 'Sustainable urban (re-)development with building integrated energy, water and waste systems', *Sustainability*, 5(3), 1114–1127.

Oral Presentations:

Integrated urban water management towards increased water security in cities (a short presentation)

Sarantuyaa Zandaryaa (UNESCO-IHP)

- > Water quality is at the core of the Water-Soil-Waste nexus. There is a need to shift towards a new concept of treating and disposing wastewater and waste and to promote greater safe reuse of wastewater for nutrient and water recovery.

It's about sanitation not sewers: The future of urban water management

Max Maurer (Swiss Federal Institute of Aquatic Science and Technology and Switzerland Institute of Environmental Engineering)

- > We need to stop focussing on toilets, but on entire sanitation systems that are sustainable under the given circumstances. This is a tremendous research and implementation challenge.

SEMIZENTRAL: Opening of the first semi-centralized supply and treatment center in Qingdao

Peter Cornel, Susanne Bieker and Johanna Tolksdorf (Technische Universität Darmstadt)

- > SEMIZENTRAL is an infrastructure approach for cities. Each urban district is provided with an integrative infrastructure system for water, wastewater, and waste, adapted to the respective needs.

The Climate Change impacts on the Highland cities of La Paz and El Alto and the climate change policies strategies to cope with the potential water scarcity

Mauricio Zaballa Romero (United Nations Environment Programme-Technical University of Denmark Partnership), María Renee Pinto Romero (Autoridad Plurinacional de la Madre Tierra) and Margot Franken (Fundación SIMBIOSIS)

- > The climate change is affecting the availability of fresh water in the Andean cities located at high altitudes. This article will revise what the cities of La Paz and El Alto are doing to cope with the potential water scarcity.

SMART WATER GRID or New Orleans freshwater nexus

Jörg Sieweke (University of Virginia)

- > New Orleans municipal water supply depends on the Mississippi. This concept provides water supply security by retrofitting networks of drainage system as a back-up source of fresh water purification and supply.

Impact of poor urban stream management practices on flood risk

Angeliki Mentzafou and Elias Dimitriou (Hellenic Centre for Marine Research-Institute of Marine Biological Resources and Inland Waters)

- > Models were used to examine the impact of poor stream management practices on urban flood risk. Decrease of cross sections may cause flood events. IUWM must also focus on stream management.

Water and energy nexus in Bangalore city and possible solution of water supply

Reba Paul (University of Queensland) and Gautam Joshii (Individual Consultant)

- > This paper describes the water and energy nexus in Bangalore city and provides a solution for meeting its water demand using alternate sources of water rather bringing water from a far river source which involves huge energy consumption.

Poster Presentations:

Supporting decisions in water management by exploring information and capacity gaps: Transferring experiences from an IWRM study to the Nexus Approach

Marco Leidel (TU Dresden) and Frank Blumensaft (Swiss Federal Institute of Technology Zürich)

- > Management framework that aligns model-based systems analysis with capacity assessments as a concept for improving cross-scale and cross-sectorial interactions within the Nexus Approach.

Potential impacts of urban area expansion on water budget and groundwater level in the Gaza Strip: An integrated modelling framework

Tamer Eshtawi (Center for Development Research [ZEF], University of Bonn, Germany), Mariele Evers (University of Bonn) and Bernhard Tischbein

- > Integrated modelling is a key to improve the spatial information base and provide appropriate management indicators to formulate realistic decisions related to sustainable urban water planning.

Towards sustainable sanitation solutions in small settlements in Central and Eastern Europe

Tjasa Griessler Bulc (University of Ljubljana), Richard Müller (Global Water Partnership) and Darja Istenic (Global Water Partnership)

- > There is low recognition of sustainable sanitation solutions for small settlements. Awareness rising on closing the loops of nutrients and water is crucial for all levels of stakeholders.

Planning integrated urban water management and river restoration: Case study in Tepic Nayarit, Mexico

Mauro Lafratta (University of Naples), Gabriela Espinosa Gutiérrez (Hamburg University of Technology), Massimiliano Fabbicino (University of Naples) and Ralf Otterpohl (Hamburg University of Technology)

- > Integrated approach for urban water management in a Latin American middle-sized city improves the ecological status towards a sustainable system protecting water, saving energy and food production.

Decentralized wastewater reuse to address water energy food nexus using GIS in Leh Town, Ladakh, India

Daphne Gondhalekar (Center for Urban Ecology and Climate Adaptation [ZSK], Technische Universität München)

- > This paper discusses operationalizing the water-energy-food nexus through decentralized wastewater management in a small town Leh in the high-altitude region Ladakh in India.

Leading Conveners:

Deutsche Gesellschaft für Internationale
Zusammenarbeit (GIZ),
Carmen Vogt and Jan Schlenk

Co-Conveners:

UN-Water Decade Programme on Capacity Development (UNW-DPC), Jens
Liebe and Daniel Tsegai
UNU-FLORES, Mathew Kurian

In today's rapidly urbanizing world, urban growth leads to numerous conflicts and tradeoffs on resources and land within its surrounding areas. Rural areas depend on urban market for income, while urban areas depend on ecosystem services (for their daily supply) provided by their surrounding areas. The Urban NEXUS approach highlights the critical linkages between urban and rural areas, especially the nexus between energy, water, and food security, as well as land or waste management.

The session highlighted functional and spatial rural urban linkages as an important leverage to foster resource-efficient and sustainable urban and metropolitan development. Besides the upcoming challenges of urban sprawl and the use and reuse of limited resources, the potential and opportunities for resource efficient planning in metropolitan regions have been in the center of the debate. The session bridged the gap between technical solutions and necessary frameworks for implementation such as governance settings, inter-institutional cooperation, sector policies and coherent development agendas.

The contribution of sustainable urban governance was highlighted throughout the session: The Urban NEXUS¹, as an approach of integrated urban and regional planning and management, supports the integration of different stakeholders on an urban/metropolitan level to implement innovative technical solutions. Thus, by applying the Urban NEXUS approach, these solutions and good practices can be transferred to the policy level. In this context, the need for capacity development was highlighted by sharing experiences from UN-Water Decade Programme on Capacity Development (UNW-DPC). The project 'Safe Use of Wastewater in Agriculture' (Water-Energy-Food Nexus) and the worldwide capacity development activities surrounding drinking water loss reduction (Water-Energy Nexus), demonstrate the necessity of capacity development to address the issues of overcoming institutional and managerial silos. The governance and capacity building aspect of the session was supplemented by technical solutions (Monitoring: Fecal Waste Flow Diagram (SFDs) and Financing: Output-Based Aid) and the Case Study 'Pro-urban water allocation in Vu Gia' (Thu Bon river basin, Vietnam) in the context of international development cooperation.

The contributions highlighted the extension of the Nexus Approach beyond environmental resources. Two case studies from metropolitan areas in Honduras and Philippines on Output-Based Aid (OBA), presented by UNU-FLORES, linked the nexus of water and waste to finance. OBA offers a best practice experience of a management option that could lead to more reliable and better service provision to those that would not be able to afford such services. Voices from the audience questioned the involvement of private, profit seeking companies in these projects. Nevertheless, it was recognized that if incentive structures were properly designed, a social benefit could arise from pursuing this type of financing model. The key recommendations emerging from UNU-FLORES' presentation included: (i) the need to engage local governments

¹ The Urban NEXUS project 'Operationalization the Urban NEXUS approach in cities and metropolitan regions' was undertaken by GIZ and ICLEI – Local Governments for Sustainability in cooperation with and commissioned by the Sector Project 'Sustainable Development of Metropolitan Regions' – on behalf of the BMZ.

at the city level and (iii) the need for a better understanding of interconnections between bio-physical resource use, public financing and changes in the institutional environment.

Concerning the global trend of urbanization, the session highlighted that a multi-level governance approach and capacity building for political stakeholders are necessary for the implementation of nexus solutions. From a governance perspective, it is important to elaborate comprehensive frameworks (e.g., Fecal Waste Flow Diagram; Waste-to-Energy Concepts) in order to implement already existing technical tools and solutions on the policy level. Further, upscaling the emerging good practices in the water and sanitation sector is necessary to identify connecting factors and the transferability of the solutions to other urban service sectors.

The session contributed to the conference's aim by emphasizing the crucial role of cities and metropolitan regions for reaching the targets of the SDGs. The session contributed to the SDGs' 'Urban Goal' by stressing the metropolitan perspective in respect to the efficient management of (natural) resources. To reach the other, crosscutting SDGs, the nexus perspective bears the potential for a direct contribution. The experiences/lessons-learned in capacity development connecting the water/waste water use in agriculture by UNW-DPC contribute directly to the implementation of intersectoral projects/programs by transferring them to other settings.

Concluding, recommendations from the session's discussion can be conveyed on different levels:

- Functional rural urban linkages are an important leverage to foster resource-efficient and sustainable development in a rapidly urbanizing world. The crucial interdependencies between urban areas, peri-urban areas, and the ecosystem services of the surrounding areas highlight the need for integrated resource management. While the technical solution illustrates the feasibility of such approaches, there is a gap of governance and capacity building instruments to implement those technical solutions.
- The rural-urban linkages highlight the importance of a continuous spatial perspective regarding urban planning, which includes peri-urban and the rural areas. The impact of urbanization goes beyond the traditional administrative cities boundaries. (e.g., 'Pro-urban water allocation in Vu Gia')
- The technical tools are available to connect different sectors (e.g., Fecal Waste Flow Diagram, Output-Based Aid), but, in order to promote and mainstream them, there is a necessity of diffusion and distribution.
- There is a need to accompany the technical solutions with capacity development to successfully apply integrated approaches. Experiences by UNW-DPC in the water and waste water sector emphasized this aspect. The institutionalization of intersectoral cooperation is necessary to ensure sustainable planning on urban/metropolitan scale.

Oral Presentations

Operationalizing the urban nexus in cities and metropolitan regions

Carmen Vogt, Alexandra Linden and Jan Schlenk (GIZ)

- > Recent findings on the 'Urban NEXUS' as an inter-sectoral and multi-actor approach towards resource-efficient and integrated cities and metropolitan regions.

Operationalizing the urban Nexus Approach: The City of Nashik optimizing water, energy and land resources in peri-urban agriculture

Jeb Brugmann (The Next Practice), Kathrine Brekke and Ritu Thakur (International Council for Local Environments Initiative)

- > Highlighting the perspective and challenges of local governments, the presentation will give case examples of 'Urban NEXUS' projects and approaches being implemented in cities around the world.

More people, more problems? How can capacity development help to capitalize on the nexus opportunities in urban and peri-urban areas?

Jens Liebe (UNW-DPC), Daniel Tsegai (UNW-DPC) and Reza Ardakanian (UNU-FLORES)

- > Capacity development is essential to advance the implementation of the Nexus Approach so that urban and peri-urban areas can sustainably benefit from the opportunities of integrated resources management.

Sustainable sanitation at the centre of Water-Energy-Food Nexus

Kim Andersson (Stockholm Environment Institute), Patrick Bracken, Arne Panesar and Rahul Ingle (GIZ)

- > This presentation aims at analysing the possible contributions sustainable sanitation systems could make within a Nexus Approach through inter-sectorial discussions

Pro-urban water allocation - case study of Vu Gia - Thu Bon river basin

Viet Ha Nguyen (University of Bonn)

- > This research highlights urbanization processes and aims to close the gap between theory of and current formal and informal practices in river basin water management by analyzing water use planning procedures and optimizing water allocation in a river basin in the context of multi-sector water use conflicts (electricity generation, agricultural production, increasing urban domestic use).

Nexus planning approaches and Instruments

Mathew Kurian and Kristin Meyer (UNU-FLORES), Mario Suardi (The World Bank)

- > UNU-FLORES recently completed three case studies that highlight the planning aspects of implementing OBA approaches through analysis of water and wastewater management projects in Honduras, Tanzania and Philippines.

Poster Presentation

Challenges of equity in a rapidly urbanizing Africa: An ecosystem services perspective

Blal Adem Esmail and Davide Geneletti (University of Trento)

- > This presentation shows methodology to optimize watershed investments to enhance ecosystem services and addresses equity concerns by unveiling trade-offs between equity dimensions and ecosystem services return to investment.

S10

DATA HARMONIZATION AND EVIDENCE-BASED DECISION MAKING IN PERI-URBAN REGIONS

Leading Convener:

United Nations Human Settlements Programme (UN-Habitat),
Graham Alabaster

Co-Convener:

Institute for Global Environmental Strategies (IGES),
Bijon Mitra and Pham Ngoc Bao

Data plays a critical role as a basis for evidence based decision-making. Yet availability of reliable data is a serious concern in developing countries. For management of environmental resources, such as water, that are characterized by both flow and stock, the availability of point and non-point data is crucial. The inability to collect and analyse continuous data covering differing temporal scales, disaggregated by users and potentially with multiple uses can result in fragmented decision-making processes.

The usefulness of data for decision-making will depend on a variety of factors. In most cases, data collected at the local level will be most useful applied locally. Data with regional dimensions will also serve to allow local comparisons. New technologies are now available to collect such data but are only so affordable in the more developed economies. There are potential opportunities to increase the use of so-called human sensor webs. With some adaption, they can usefully be applied to low-resources situations. Definite benefits in using a Nexus Approach for water quality monitoring have been widely documented. In such cases, however, all relevant ministries need to be consulted, not just those responsible for environmental protection and water management. Local authorities will play a key role in remediation strategies that need accessible data at the local level. One key issue is the ability to give real time information to decision makers. On many occasions, outdated information results in ineffective management decisions.

Several presentations in the session and subsequent discussions highlighted the need to focus on highlighting the cost-benefits of Nexus Approaches. The main impediment seems to be that compartmentalised approaches from different line ministries do not communicate for mutual benefit. A good example given in the session concerned the relationship between planning for energy production facilities and availability of water resources. Future predicted energy demands can easily outstrip available water resources. Conflict for water resources between power generation and agricultural needs also exerts additional pressure. Effective solutions will require a more holistic approach encompassing integrated planning. Newer technologies for power generation, which require significantly less water, must also be considered.

The concept of protection zones for water resources planning was also cited as an appropriate approach where multiple risk factors from urbanization, agricultural practices and resource use has direct and significant impacts. In certain situations, this approach can greatly assist in planning for infrastructure provision. A good example was the case study from Palestine, where local sanitation practices favour the introduction of networked solutions for wastewater disposal.

In many cases, a regional approach to promote Nexus Approaches has demonstrated good success, in conjunction with local actions. Through consideration of the current situation and policy needs, the Water Environment Partnership in Asia (WEPA) aims to promote good governance in water environment management by providing necessary information and knowledge of water environment management in the region through databases. It further aims to develop the capacity of relevant stakeholders by working together on the construction of the databases. Some 13 countries have joined the partnership. The partnership provides regional evidence for local decisions and serves as a good platform to exchange information on science and policy.

The complex factors related to social vulnerability and nexus issues also warrant attention. Certain social groups, farming communities for example may not be aware of the complex issues related to climate change and water availability, especially as they are more used to natural drought episodes to affect their livelihoods.

Sustainable water and sanitation are relevant to all sectors of the economy and recognized as one of the major issues in the discussion on SDGs and in relation to promoting Nexus Approaches. The data revolution is high on the post-2015 development agenda, as has been repeated in all post-2015 documentation. Water scarcity and declining water quality are concerns in almost all countries, spanning all levels of development. More comprehensive information on both their current status and trends would enable Member States to better make evidence-based development decisions for more sustainable development, management and use of sanitation and water resources. Earth observations, including satellite and in-situ measurements, have reached a level of maturity where they could assist in the routine monitoring of the proposed indicators. The opportunities for Earth observations and data integration are excellent. Earth observations and scenarios for integrating them with other sources such as surveys, administrative records, regulators or Big Data are likely to form the cornerstone of SDG monitoring in the coming decade. If Earth observations capabilities are linked to the proposed indicators, mechanisms can easily be developed for a wide variety of SDG indicators.

Oral Presentations:

Water energy Nexus Approach: Toward harmonization of water and energy in sustainable resource management – Case of India
Bijon Kumer Mitra and Anindya Bhattacharya (Institute for Global Environmental Strategies)

- > Unless water and energy security are addressed together, it is quite likely that the planned electricity generation will be negatively affected; alternatively, other water use will be compromised, economic development will suffer.

Point source water quality monitoring strategies and management in Korea

Eulsaeng Cho (Korea Environment Institute)

- > The introduction of Water TMS in Korea resulted in the considerable decrease of effluent pollutant load. It also intended to induce for the point source dischargers to voluntarily improve the treatment efficiency by monitoring the effluent constituents in real-time as well as by reporting the discharging status to regulatory agencies.

Feasibility of protection zones for water resources in arid areas: Case study – Ein-Sultan Spring, Jericho, Palestine

Marwan Ghanem and Mahmoud Hamad (Birzeit University)

- > The economic multiple users technique for a multi-years cost benefit analysis is used to approach the protection zones feasibility of spring water in Ein-Sultan, Jericho as a Case Study for arid areas.

Multi-component web-based decision support for management of water resources

Catalin Stefan (TU Dresden)

- > Development of a multi-component DSS on an interactive web-based platform that combines a comprehensive knowledge base with a process based scenario analysis tools for water resources management.

Using Earth observations, novel data and data integration to monitor progress toward the UN SDG for Water

Rifat Hossain (WHO and Earth Observation Task Force)

- > An assessment shows how Earth observations (EO) can contribute to the UN Water SDG. To realize this benefit, organizations need to adopt an inclusive framework for acquiring and processing EO data.

Poster Presentations:

Multi-criteria analysis approach of adaptation actions in Dar es Salaam, Tanzania

Nathalie Jean-Baptiste, Oliver Gebhardt, Volker Meyer (Helmholtz Centre for Environmental Research (UFZ)) and Stelios Grafakos (Institute for Housing and Urban Development Studies)

- > This presentation uses a multi-criteria analysis (MCA) to respond to flooding in Dar es Salaam by finding gaps in current mainstreaming initiatives and developing an approach for participative decision-making for adaptation using MCA tools.

Multi-component web-based decision support system for management of water resources

Catalin Stefan, Aybulat Fatkhutdinov, Jana Sallwey, Jana Ringelb, Thomas Fichtner, Jinxing Guo and Peter-Wolfgang Gräber (TU Dresden)

- > The development of a multi-component decision support system on an interactive web-based platform is used to combine a comprehensive knowledge base with a process based scenario analysis tools for water resources management.

S11

NEXUS MONITORING STRATEGIES AND MANAGEMENT OF ENVIRONMENTAL RESOURCES

Leading Convener:

UNU-FLORES, Mathew Kurian

Co-Convener:

Arghyam Foundation, Neelima Thota



There are numerous data sets available worldwide on different aspects of environmental resources (examples include forest cover, rainfall or soil erosion rates). From academic sources there are a number of data sets available that can potentially define principles that

promote integrated management of environmental resources. The serious problem is not the lack of data itself but the inability of the research process to provide a context to results of field trials and controlled experiments. This challenge lies at the heart of the science-policy divide; fragmented decision-making processes in developing countries is less a result of poor science and more a result of a poor understanding of the policy process. Therefore for us to understand the basis for robust regimes for management of environmental resources, a substantive understanding of the services that are provided by stewardship of forests, water or soil resources is essential.

The session was co-convened by GIZ, UNW-DPC and UNU-FLORES. The session brought together members of the Africa regional consortium on drought risk monitoring and Asian partners to share tentative results of the Nexus Observatory network. The discussion attempted to identify links between resources, services and risks covering irrigation, water supply and livestock sectors. The following objectives were accomplished as a result of the discussions in S11:

- feedback on commissioned studies on the water-soil nexus in Africa
- engagement of policy makers involved in discussions on a post-2015 monitoring framework – indicators, tools, approaches
- feedback on conceptualization of proposed Asia Nexus Observatory network on water-wastewater nexus
- feedback on approaches for nexus monitoring in the post-2015 development agenda
- feedback on key models for building capacity and engaging member states



Photo: R.Vigh/IOER.

Oral Presentations:

The Soil Leadership Academy approach to support LDN objective

Alexandra Marchis (United Nations Convention to Combat Desertification (UNCCD))

- > The Soil Leadership Academy (SLA) works to narrow the science-policy divide by supporting local governments to build capacity at regional level. The concept of the Soil Leadership Academy (SLA) and its implementations will be discussed.

Water point mapping as a drought risk mitigation tool in Africa: The case of rural water supply in selected districts in southern Malawi

Sandram Maweru and Thanasius Sitolo (Ministry of Agriculture Irrigation and Water Development, Malawi)

- > Decentralization has brought decision-making close to water users. Water point mapping assists in mitigating climate change impacts. The study involves the mapping of water points in the district.

Water Point Mapping as a Drought Risk Monitoring Tool for Irrigation

Abraha Adugna Ashenaafi (Water Resources Bureau)

- > As there are many challenges facing water point mapping project in Africa, capacity development can help to improve monitoring of drought risk monitoring in Ethiopia.

Towards water security: Addressing the groundwater-sanitation nexus

Neelima Thota and Gayathri Lalu (Arghyam Foundation)

- > Poor sanitation practices have an adverse impact on shallow groundwater and this affects the water security in a country like India where 85% of the population depends on groundwater for the domestic requirements. Groundwater – Sanitation nexus study and understanding assumes greater significance in such a context.

How can capacity development help to capitalize on the nexus opportunities in Africa?

Shija Kazumba (Water Management Institute)

- > Capacity development can be used to improve monitoring of drought risk monitoring in Tanzania.

CONCLUDING TALK OF THE DAY

Stephen Curwell

Heys Environmental Consultants Ltd

Managing Director



Photo: R.Vigh/IOER.

To begin with, we view of Earth from space – as an effective reminder to the whole of human society of the fragility of the ecosystem, which is as powerful as a summary of some of the dangers identified by presenters the first two days of the conference, such as:

- 4 x increase in CO₂ since 1950
- 40% more water needed and 50% of mankind in water stress by 2035
- 70% urbanisation of population by 2050 and 7 billion in cities by 2100
- 58% overshoot in resource use (2 other planets needed!).

So how do we address this? Three key points can be identified; the first is the changing role of cities in an emerging knowledge society (KS). When more people in the world have a cell phone than have a toilet (Time Magazine 2013) and 40% of the world's population is on the internet (up from 1% in 1995) it is important to recognise the potential effect of the KS on the subject of the Water-Soil-Waste Nexus. We move rapidly towards Bill Mitchell's 'E'topian vision of ICTs with the 'intimacy of underwear'. The KS has been the main development policy plank, particularly in the European Union since 2000, and the vision was and is for soft transformation towards a sustainable KS without the old environmental consequences (pollution, resource depletion, etc.).

Central is an E agora – where consensus over appropriate urban change can be promoted and/or emerge, but the jury is out on whether such a forum can help us to decide what type of (eco-) city we want.

This is very relevant to the second key point: the relationship between the city and its hinterland; do we want to live in Phoenix, Arizona – a city in the desert where everything has to be imported and it is essential to have a car and air conditioning? Or is it Durban, SA, close to food production, better public transportation but a huge contrast in wealth between the haves and have-nots? Florence, Italy is many people's ideal – lovely climate and city centre ideal for walking; but many of Florence's residents are not so sure because it is not really suitable for most aspects of a modern mobile, ICT powered society and feel the heritage is strangling modern development. Issues around the city and its hinterland have been explored, such questions as can space be made for farming/food production inside the city or do we build in the green belt. Many of the papers promote more constructive use of the peri-urban area for environmental and health improvement, water production, food, energy, etc.; so the nexus between the city and its hinterland is likely to be a development battleground in the future. To avoid this, some papers promote green retrofitting, of buildings, of infrastructure, for example, better public transport [aka the UK Urban Task Force]. We know we can each radically reduce our CO2 footprint if we consume, drive and fly less. But, as the statistics show, we don't choose so to do.

This form of denial highlights the last key point to emerge: the relationship between politics and effective change management, and how human society needs to address the dangers to the ecosystem whilst avoiding unintended consequences that might make matters worse. Aspects of transition to the Eco-City in many of the papers emphasise the importance of restating the UN's Sustainable Development Goal 11 for urban re-development and regeneration. For this institutional change is essential because 'information does not necessarily lead to increased awareness, and increased awareness does not necessarily lead to action [these] must be backed up by other approaches' (Demos/Green Alliance: Carrots, Sticks and Sermons 2003).

So it is so difficult to achieve the shared vision identified by Constanza and Kubiszanski (DNC2015 position paper) as vitally important to nexus problem solving. The long-standing professional educational deficit (e.g., the UK's Sustainable Community Development Skill's review) means that professionals have to completely rethink their role and see themselves not as experts but as community enablers and facilitators. The papers show good pilot studies and more are needed to demonstrate how it can be done. However, key to this is trust between citizens, professional advisors and the politicians because the political imperative means something has to be achieved in each 4-5 year electoral cycle.

To conclude; we need to (plan for the upside of down) so that good quality, but less resource intense lifestyles can emerge. To do this will require the forms of co-production of change that are shown or implied in many of the papers, so there is hope. Central will be the new nexus between the urban, natural and virtual (KS) environments.

PANEL DISCUSSION

Moderator	Bernhard Müller, IOER Director
Panelists	Yongha Park, Korea Korea Environment Institute, Former Director General Korea Adaptation Center for Climate Change Shija Kazumba, Tanzania Water Development and Management Institute, Chief Executive Officer and Principal Thi Lien Mai, Viet Nam Ministry of Construction, Deputy Director
	Lead Conveners from S6, S7, S8, S9, S10 & S11

DAY 3: POPULATION GROWTH AND THE INCREASING DEMAND FOR ENVIRONMENTAL RESOURCES

KEYNOTE SPEECHES



THREE POLICY PRIORITIES FOR SUSTAINABLE DEVELOPMENT

Michael Herrmann

United Nations Population Fund,
Senior Adviser on Population and Economics, and Manager of the Innovation Fund



The challenge that we confront today is to meet the needs of more and more people – which will demand higher consumption and higher production – without imposing catastrophic and irreversible damages on the natural environment. This is the challenge of the century; it is the challenge of sustainable development.

Meeting the needs of more and more people will demand that we better distribute what we have – this is an imperative in a world characterized by growing inequalities – but it will also require higher economic output. For example, to feed a world population of 9 billion will require that agricultural output increases by about 70 percent over current levels, according to a recent study by FAO. But not only a higher output of the agricultural sector is needed, but also an increasing production of other goods and services. More people will also need more water and energy, clothing, housing, infrastructure, health and education, amongst others.

The production of goods and services inevitably depends on the transformation of natural resources. This will place mounting pressures on all natural resources including water, land, forests and the climate, which are an essential as well as finite basis of life. Business as usual is not an option. Failure is not an option. Failure would either mean a failure to reduce poverty and fight rising inequalities, or it would lead to catastrophic and irreversible damages to the environment, and either would spell unimaginable humanitarian crises. Humankind has manoeuvred itself between a rock and a hard place, but still has choices.



One policy priority is clearly to ensure that we are getting more social progress for any unit of economic growth; this is often discussed under the heading of 'inclusive economies'. Another policy priority is to have a lower environmental impact for any unit of economic growth; this is often discussed under the heading of the 'green economy'. However, there is a third policy priority, and it is a very important priority indeed. We must address and harness population dynamics for sustainable development.

Whether the world population will grow to about 10 billion by the middle of the century and level off at about 11 billion by the end of it – as suggested by the medium variant of the UN's population projections – or whether it will follow another trajectory, largely depends on today's policies. Small differences in fertility add up to large differences in population numbers over time. If on average every woman has only half a child more than assumed by the medium variant, the world population can grow to 17 billion by the end of the century; if every woman has on average only half a child less, it could shrink to about 7 billion instead.

Contrary to common beliefs, population dynamics can be shaped by policies, and such policies can in fact strengthen fundamental human rights and freedoms. The realization of sexual and reproductive health and rights and unrestricted and universal access to sexual and reproductive health care information and services can make a world of difference. However, efforts to shape population dynamics must be complemented by efforts to plan for projected population trends in the years to come.

Realizing the right and access to sexual and reproductive health care, including voluntary family planning, together with greater investment in and access to education, including comprehensive sexuality education, can make a big difference for people, communities and societies as a whole. Together these measures will empower women and families; they will curb infant, child and maternal mortality; the spread of communicable diseases; unintended pregnancies of adolescents; the psychological, physical and financial burden of diseases; and they will also contribute lower fertility, slower population growth, demographic transition and more sustainable development.

Population dynamics do not only pose challenges to sustainable development, they also provide important opportunities for more sustainable development pathways. A fall in fertility levels and slower population growth will create the conditions for countries to realize a demographic dividend and higher economic growth. Migration enables people to respond to adverse social, economic and environmental change; and with the right policies urbanization can promote more sustainable living. In urban areas, people have lower energy consumption, adjusted for income levels, than in rural areas; and in urban areas, public authorities can provide essential goods and services at lower costs per person than in rural areas. However, realizing these opportunities is by no means an automatic process.

To realize the opportunities associated with population dynamics, including migration and urbanization, is critically dependent on evidence-based analysis and forward-looking policies. Authorities will need to systematically collect population data, use population data and projections, examine population-development linkages and plan for unfolding population dynamics. Doing so, they can address and avoid many of the associated challenges. Rather than operating in a permanent crisis mode responding to emerging challenges; they could shift towards developmental mode and focus on realizing opportunities.

Many are casually using the term 'people-oriented' or 'people-centred' development strategies. If we want to be serious about it, we must rigorously use population data. We need to know

how many people are living and how their numbers will change, where they are living and how their spatial distribution will change, and how old they are and how age structures will change. Otherwise, we will not be able to truly understand the changing needs of our populations, and will not be able to meet their needs.

The current draft of the Sustainable Development Goals is better in some regards than others. As it stands, it emphasizes many of the determinants of population dynamics – health, including sexual and reproductive health, education, including secondary education and gender equality, amongst others – but it falls short when it comes to planning for demographic change. The current draft pays too little attention to the collection of population data, the production of population projections, the analysis of population-development linkages and the use of population data and projections for planning purposes.



THE INTEGRATED MANAGEMENT OF THE LAND RESOURCES: INSTITUTIONAL TOOLS

László Miklós

Technical University in Zvolen (Slovakia),
UNESCO-Chair for Sustainable Development and Ecological Awareness



The Geosystem: The Physical base for the integrated management of land resources

The geosystem – a material reality of the geosphere – is scientifically defined as the set of the components of the geosphere and their mutual relations. It is a material object to be respected in all types of integrated management. The Nexus Approach is without doubt an integrated approach. The initial nexus comprised water, energy and food – the basic geosystem elements and their relations; the geosystem is the vessel for water (the watershed, aquifer of underground water), is the source of energy (geo-, solar-, renewable) and is at the foundation for food production

(soil and climatic conditions). The newer Water-Soil-Waste Nexus includes also the human-made or allochthonous materials within the system components. But none of these nexus elements – water, energy, soil, food or waste – is isolated, they exist only in integrated form. Moreover, they are not isolated from the other components of the geosystem, such as, the atmosphere, the georelief, the geological base, the biota, the land-use elements, the human –made objects. All of them are interrelated, which clearly highlights the need to encompass all of them in an integrated management process.

But what is happening in reality? Nowadays sectoral approaches to resource management still strongly prevail. We have separate management approaches for each resource or sector, such as, air pollution management, soil management, water management, mineral resources management, waste management, building codes, conservation of biotic species and so on.

Integrated management of land resources: A basic introduction

While the integrated approach is absolutely necessary in the present day, at the same time it is also a fashion, a mainstream, trendy term in science, a favourite theme for politicians. But, does everybody know what it really is? We can at least say there are different understandings! However, the approach is not new. The Agenda 21 from Rio Summit 1992, Chapter 10: 'Integrated approach to the management of land resources' said that there is only one landscape, one area – it must be accepted by each sector, all activities may have their own area but in the same landscape. And they can conflict; therefore an integrated approach is needed for their use. The fundamental tool of such management strategies is integrated physical planning, which must act as a frame and basis for the plan of each sector. What is an integrated plan – it is framework outlining the optimal organisation and utilisation of a territory for all sectors simultaneously. Taking the whole territory into consideration, it answers the questions: what, where and how? Those provisions of Agenda 21 are still valid, still not exhausted!

Institutional tools for integrated management and their integration

From the abovementioned, it is obvious that there is no single tool for integrated management but a harmonised process of several spatial planning procedures, where the final goal is defined as the harmonisation and satisfaction of the demands of different – if possible, all – sectors with respect to sustainable development. What tools existing in developed countries can be integrated? There are tools of the following but separate types: the spatial planning tools dealing with land, forests, watershed, urban territories, nature conservation areas, etc. Such tools include, among others, the physical (territorial, spatial) planning, regional planning, urban (settlement) planning, watershed (water management) planning, flood management planning, agricultural land arrangement (land consolidation) planning, land-use planning, forestry planning, ecological network planning, all supported by law. The main problem remains their integration.

One basic precondition is to make integration obligatory by law. A clause from the Act No. 7/2010 Z.Z. on Flood Prevention in Slovak Republic, may serves as example: §9 on coordination of management plans reads as follows: ' ... plan of the flood risk management and the watershed management plan shall be coordinated with the land arrangement projects, the territorial plans, the forest management plans. They altogether will constitute the tool of integrated landscape management on the whole territory of the watershed.' In the same Act is the statement of the necessity of an integrated information system, as the basis for the whole process.

Another precondition is the right methodology and the topic-time systematisation of those tools. According to their character and successive role in the integrative process we may rank them in four groups, as:

- a) the integrated spatial **informational base** (obviously GIS based)
- b) the landscape-ecological and **physical** (spatial, territorial) **frame** (as the landscape planning, econet planning, physical planning)
- c) traditional **sectoral** planning and management tools (water, forestry, agriculture, urbanisation, transport, industry planning), as **executive** tools
- d) tools of integrated character for the **assessment and regulation** of impact on environment (E.I.A., IPPC)

The logical succession of those tools – **informational base to physical frame to execution to assessment** – is crucial for their integration. The basic precondition for the integration of the sectoral planning procedures (mentioned under c.) is a unified complex information GIS-base, and, a landscape/physical plan as legal, obligatory frame and obligatory regulation for each sectoral plan, as it was stated already in the provisions of Agenda 21. Just as an example: the key integrative ecological element in Slovakia is the econet planning (biocentres, biocorridors, ecostabilising elements), named as Territorial System of Ecological Stability (TSES), which is determined in all mentioned Slovak acts.

Problems of the implementation

Beside different understandings of the concept of integration (rarely, as the integrative decision-making on the use of the whole landscape for each sector) and the methodical and legal problems, a problem of another type is the political will for integration. Everybody proclaims the need for integration, but only few of them wish to accept it. Sectoral approaches are very common and prevailing. Resistance by sectors to integrate under any trans-sectoral concept/planning/decision-making process prevails, resistance to accept the nature and landscape limitations as obligatory regulations is strong, as well as the resistance of the communal authorities and other interest groups. Sectors and companies consider integration, the 'Nexus Approach', only if it offers short-term savings/profits, not looking at other sectors.

Nevertheless, we can expect increased pressure on natural resources, which will increase competition between sectors. Therefore, the need to speed up the implementation of an integrated approaches, including the Nexus Approach, the IWRM and others, is urgent. The danger of simplification, formalisation, and over-politicisation of the approach is to be recognised. This can weaken and flatten the professional consideration of the material basic components and their relations – the geo-system, therefore the need to enhance capacities of institutions to address trade-offs between sectors is obvious.

All this also needs changes in education. Integrated management is not one single topic of study, but a systematically organised set of topics. Studying this requires a balance of ecological and environmental topics (geographical disciplines, landscape ecology, environmental disciplines), technical topics (basic industrial, agricultural, forestry, construction knowledge), as well as social-sciences topics (law, economics, management).

All these problems are solvable, but solving them depends on people!

SESSION REPORTS

S12

ASSESSING THE ROLE OF SOIL FUNCTIONS FOR ACHIEVING SDGs

Leading Convener:

Leibniz Centre for Agricultural Landscape Research (ZALF),
Katharina Helming and Nadia Glaesner

Co-Conveners:

Helmholtz Centre for Environmental Research (UFZ),
Hans-Jörg Vogel; UNU Institute for Natural Resources in
Africa (UNU-INRA), Effiom Oku

Soil functions and services play a decisive role in the interplay between food supply, biodiversity maintenance and environmental health. They include provisioning functions for food and biomass production, raw material, physical and cultural environment for humankind, supporting functions for storing, filtering, transformation, recycling, habitat and gene pool, and cultural functions as archeological sites and cultural identity. Yet, the interactions between soil functions, their spatio-temporal patterns and their impacts on SDGs are not well explored. There is a principle understanding about how soil management affects soil functions, but the next causal step about how exactly soil functions affect SDGs where and when is not understood, not monitored and not assessed. It requires a fully interdisciplinary analytical design integrating soil scientific with social and economic approaches. Suitable indicators need to be identified in order to transfer the complexity of the underlying processes into a format that can be monitored and assessed. Proper and accessible information about the interactions between soil management, soil functions and soil services on SDGs is a prerequisite for integrated management of environmental resources.

The objective of the session was to discuss information requirements and research needs for exploring causal linkages between soil functions, soil services and SDGs, the underlying processes, regional patterns and spillovers. Focus was on regional challenges for improving soil functions in support of SDGs.

Soil functions and services play a paramount role for numerous SDGs, namely provisioning services for SDG 2 (end hunger) and supporting services for SDG 6 (water management), SDG 13 (climate action) and SDG 15 (ecosystem services). With regard to the policy process of SDG implementation, Knut Ehlers from German Federal Environment Agency emphasized on the need of an integrated indicators for soil services in order to make sure that the implicit mentioning of soils is not lost in the implementation phase. This could include the indicators soil organic carbon and net primary production.

Sustainable soil management in support of SDGs implies the improvement of soil rootability, soil structure, water retention capacity, soil organic matter content and soil coverage with plant residues. Site specific adaptations of tillage practices, cultivar choices, crop rotations, residue management and irrigation techniques are important management factors for soil quality. However, the right choice of those management practices depends on site-specific climatic, geophysical and agronomic conditions. There are no one-size-fits-all solutions. Expanding on regional perspectives of the interactions between soil management and soil services for Africa (Effiom Oku), China (Shaoshan An) and India (Prakasa Rao) it became clear that despite huge natural and socio-economic variations two key obstacles to sustainable soil management stand out: knowledge gaps and socio-economic innovation constraints. Knowledge gaps need to be closed at all levels of the action pyramid: awareness, research, extension and action.

Interlinkages between these levels need to be more seamlessly intertwined. Innovation constraints are often related to severe poverty and to the need for short-term benefits. As the saying puts it: it is hard to be green, when you are in the red. Small farmers do not have the options of long term investment into soil quality improvement, because they desperately need short-term achievements. In this regard, poverty alleviation measures may be separated from soil conservation measures and may go beyond the primary sector into addressing the entire value chain.

Oral Presentations

Soils and the SDGs: Partners by default?

Knut Ehlers (German Federal Environment Agency (UBA))

- > This presentation will discuss Sustainable Development Goals (SDGs) for the Post 2015 development agenda with specific interest to soil, soil functions, soil degradation and restoration and ecosystem services.

Linking soil functions to Sustainable Development Goals

Effiom Oku (UNU-INRA)

- > Africa's economy is dependent on its natural capital as soil. Sustaining MDGs and fast tracking achieving SDGs in Africa will require putting soils in front and centre of roadmap to its achievement.

Assessment of soil quality and soil anti-erodibility in different vegetation zone on the Loess Plateau (China)

Shaoshan An (Northwest A&F University) and Quanchao Zeng (Institute of Soil and Water conservation, CAS&MWR)

- > 'Grain-for-Green Program' was implemented on the Loess Plateau from 1999. Vegetation restoration had effects on the soil aggregate stabilities, nutrients, microbial biomass. Revegetation can prevent soil degradation problem on the semiarid land region.

Improving soil functions for sustainable agriculture: A case study from South India

E.V.S. Prakasa Rao (Independent)

- > Poor sanitation practices have an adverse impact on shallow groundwater and this affects the water security in a country like India where 85% of the population depends on groundwater for the domestic requirements. Groundwater – Sanitation nexus study and understanding assumes greater significance in such a context.

How can capacity development help to capitalize on the nexus opportunities in Africa?

Shija Kazumba (Water Management Institute)

- > Improvement in soil functions and crop diversification with aromatic crops in India have helped the nexus among soil functions- environment- economics - livelihoods of small farmers.

Poster Presentations

The soil dimension of food supply chains affecting SDGs

Martin Hamer (Bonn-Rhein-Sieg University of Applied Sciences)

- > An interdisciplinary approach to describe the impact of global food supply chains on soil functions considering the total food chain.

Impact of land-use change on soil organic carbon stocks and fertility in the Eastern Usambara Mountains, Tanzania

Maximilian Kirsten (TU Dresden), Carsten Müller (Technische Universität München) and Karl-Heinz Feger (TU Dresden)

- > Soil Organic Carbon (SOC) stock inventory in tropical ecosystems shows high variability, which leads to Fertility loss on Cropland ecosystems. SOC stock inventory displays data about highly leached and acidic soils, and the interrelationship between C content and Fe-/Al-oxides.

Advancing performance of green technologies for remediation and reclamation of degraded urban soils

Magdalena Sut, Katja Boldt-Burisch, Ina Pohle and Thomas Raab (Brandenburgische Technische Universität Cottbus-Senftenberg)

- > The negative impact on the ecosystems indicates the strong necessity to improve the remediation of affected sites and to advance the reclamation activities focused on ecosystems restorations.

Leading Conveners:

UNU Institute for Environment and Human Security (UNU-EHS), Zita Sebesvari and Fabrice Renaud

Co-Conveners:

University of Bonn, Jens Kruse
University of Dhaka, Mustafizur Rahman

Population growth in conjunction with urbanization drives the demand for resources for construction material for, for example, housing. In many countries with high population growth and/or urbanization rates, such as in Bangladesh, Viet Nam and India, fertile soil is increasingly destroyed to mine clay and produce bricks. The increasing demand for clay competes with the rising demands for food. In line with the aims of Day 3 of DNC2015, this session focused on impacts associated with and strategies needed to address challenges for the sustainable management of the finite resource soil. Although soil was the 'hot point' of this nexus, (irrigation) water was identified to be strongly impacted in the course of the discussion. As a consequence, irrigation needs to be strongly considered when assigning areas for soil mining. Recycling of fly-ash (waste of coal burning) or the use of stones and earth arising from construction activities (e.g., excavated earth that results from construction activities) as substitutes for clay could be part of the solution, if these alternatives meet economical and technical requirements. A lack of implementation of existing regulations (e.g., in Bangladesh) is one of the major barriers to better resource efficiency and holding land degradation.

The session fully achieved its objectives by advancing our knowledge of the impact of brick production and other mining activities on ecosystems, agricultural production as well as social structures in place, by demonstrating and discussing consequences, for example, soil fertility, irrigation, pollution, greenhouse gas emissions, labour conditions, migration and regulations in place. The session brought together environmental scientists, social scientists as well as engineers, geographers and planning experts to explore and discuss possible solutions such as the replacement of clay by alternative and more sustainable materials such as waste (e.g., fly ash) for construction.

Although scientific literature is scarce, a multi-lingual review revealed that the removal of fertile, clay-containing topsoil horizons for brick production is an increasingly serious threat to soil quality/fertility, irrigation water availability, and thus, food security in densely populated and rapidly urbanizing areas worldwide. Linking supply and demand in the rural-urban context, analysing material flows as on the regional level by considering governance issues would be useful to find sustainable solutions. Furthermore, in Bangladesh the Government received recently a suggestion for a set of measures to be implemented in order to avoid further soil degradation caused by brick production. This was seen as an important step towards raising awareness of the trade-off between bricks and crops as well as for possible solutions. One major challenge to soil degradation strategies is to follow an integration approach that combines supply-related aspects, such as, soil quality in respect to different requirements (e.g., food production, brick production), to demand related aspects, such as, crop yield figures and technical quality requirements of building material. Therefore, an interdisciplinary approach is obligatory.

As demand for locally produced, affordable construction material such as for clay and gravel is increasing in developing and emerging countries with rapid population growth and infrastructure development, it is likely that soil mining will be further extended in the future. There is a lack of scientifically solid information about the extent of the land degradation caused by soil removal for clay production worldwide, about the impacts, on the interrelations with (irrigation) water as

well as on technical aspects regarding potentials of using alternative substitutes for construction purposes and last but not least on government-related questions regarding integrated green-growth strategies in this context. Mining activities need to be better monitored. We recommend closing this gap and establishing a solid scientific basis for the development of regulations as well as alternatives. Soils degraded for brick production need to be rehabilitated, we need to work jointly to find suitable substitutes for bricks. Further, existing regulations to hold land degradation should be more effectively implemented or respective regulations would need to be put in place.

(The conveners thank Georg Schiller for his comments on the session summary.)

Oral Presentations

Selling the future? Topsoil removal in South and Southeast Asia

Zita Sebesvari, Fabrice Renaud (UNU-EHS), Mustafizur Rahman (University of Dhaka), Jens Kruse and Wulf Amelung (University of Bonn)

- > Science based recommendations are needed to avoid further degradation of soil and water resources by topsoil selling, and to assess how already degraded areas could be restored best.

Use of topsoil by brick fields threatened for agricultural production of Bangladesh

Mustafizur Rahman, Foysha Ahmed, Eeusha Nafi and Shakil Uddin Ahmed (University of Dhaka)

- > This paper will present some reports about the removal of topsoil for brick-making which threatened for Agricultural Production of Bangladesh.

Topsoil selling in Viet Nam: Current knowledge and examples

Susanne Weigand, Jens Kruse (University of Bonn), Zita Sebesvari (UNU-EHS), Wulf Amelung (University of Bonn) and Vo Thi Guong (Can Tho University)

- > The current knowledge of the extent of topsoil selling in Viet Nam and its effects on soil properties with special emphasis and examples from provinces in the Mekong delta are presented.

Improving soil functions for sustainable agriculture: A case study from South India

E.V.S. Prakasa Rao (Independent)

- > Poor sanitation practices have an adverse impact on shallow groundwater and this affects the water security in a country like India where 85% of the population depends on groundwater for the domestic requirements. Groundwater – Sanitation nexus study and understanding assumes greater significance in such a context.

Analyzing material flows of urbanization: A basis for the management of mining activities in Ha Noi City and its hinterland

Georg Schiller and Peter Wirth (IOER)

- > Urbanization results in a high demand for resources and threats to the natural environment. MFA from mining to dumping is used to support discussions on technical, environmental, socio-economic and planning issues towards green economy.

S14

THE WATER QUALITY DIMENSION OF THE WATER-SOIL-WASTE NEXUS

Leading Convener:

International Hydrological Programme (UNESCO-IHP), Sarantuyaa Zandaryaa

Co-Conveners:

UNU-Institute for Environment and Human Security (UNU-EHS), Fabrice Renaud; FAO, Lucie Pluschke; International Water Management Institute (IWMI), Pay Drechsel and Javier Mateo-Sagasta

Water quality is a determining factor in the ability of ecosystems to provide clean water and sustain healthy soils for better food security for the world's population. Water and soil are intrinsically interlinked through complex hydrological and geochemical processes. The quality of surface and groundwater resources is directly affected by land use and waste and soil management. The widespread practice of direct dumping of solid waste and wastewater into soils and water bodies, mainly in developing countries, is the primary cause of the increasing water and soil pollution. The magnitude and extent of this problem is immense in many parts of the world. How to improve the quality of water resources to enhance water and food security for the growing

population is one of the key challenges for the post-2015 sustainable development, as reflected in the proposed SDG6 target on water quality.

The session deliberated on this challenge from a water-soil-waste nexus perspective to promote integrated solutions to improve water quality through holistic measures on wastewater, solid waste and soil management because the Nexus Approach offers a framework to address the interdependencies and interactions among these three elements of natural and man-made systems. It also serves as a unifying framework to develop coherent policies and management solutions, while improving coordination and synergies across and between sectors.

The key message of the session highlights is that **a Nexus Approach is needed to develop holistic, cross-sectoral and multi-scale solutions to improve water quality and effectively manage water resources, wastewater and solid waste, while reducing water pollution from land uses and land-based activities such as agriculture, urban settlements and mining.** The practical implementation of the Nexus Approach is complex and challenging. Yet, nexus-based solutions are finding growing applications in water quality and wastewater management.

Natural wastewater treatment systems can provide effective solutions to sustainable sanitation and integrated water management, if applied at an appropriate scale. These systems under controlled and well-designed conditions offer multiple advantages, including a natural character in wastewater treatment facilities, a relatively simple technological requirement, lower operating costs, low energy consumption, and the removal of nutrients by biomass uptake. Implemented in an appropriate scale and/or combined with wastewater technologies to overcome drawbacks such as a high area requirement and low efficiencies, natural water treatment systems are proven to be effective in improving water quality and ecosystem health, while reducing untreated wastewater disposal.

Significant water quality improvements can be achieved by increasing efficiency in all uses of water – thus wasting less and polluting less – increasing the use of non-conventional water resources and reusing more wastewater. The safe use of non-conventional water resources such as rainwater harvesting and desalination need to be promoted, as it can contribute to meeting water demand gaps in water scarce areas and in rural communities with no water services. It also contributes to increased food production and income generation for local populations. However, the direct use of untreated harvested rainwater for drinking and household uses is common in some parts of the world, despite its health risks. There is a need to promote the safe use of rainwater through measures to reduce contamination during collection and storage, regular monitoring of harvested rainwater, and educating users about health risks and safe use and storage.

Safe reuse of wastewater is vital as a source of reliable water supplies for different uses. Wastewater is a valuable resource. Wastewater reuse is becoming more than a necessity due to shrinking freshwater resources and growing water demands. Safe reuse of wastewater strengthens the water-food nexus, while addressing water pollution and water scarcity problems at the same time. The biggest challenge in wastewater reuse is risks to human health, food safety and the environment. With advanced and innovative technologies, safe wastewater reuse is becoming a feasible solution, while meeting health and food safety concerns.

A nexus-based monitoring is needed to develop effective solutions to improve water quality and support the post-2015 SDGs implementation. There is an urgent need to improve water quality monitoring to ensure water security and food safety. Effective monitoring is needed not only to assess the quality of water resources but also to monitor linkages between surface, ground- and

non-conventional water resources (i.e., wastewater reuse). A nexus-based monitoring responds to this need. Furthermore, it provides a framework to monitor drivers, pressures, states and impacts, which are essential for developing holistic solutions. As existing data on water quality and wastewater is scarce at national and global levels, improving water quality and wastewater monitoring is also essential for the implementation of post-2015 SDG water targets.

Water quality is at the core of the water-soil-waste nexus due to its multi-dimensional effects on human health, food security, ecosystems and their goods and services, and water security of nations. Cross-sectoral, coherent and holistic strategies based on the Nexus Approach and better integration and coordination of sectors are a key to sustainable water quality and wastewater management as a nexus-based approach provides a framework to manage water resources more effectively and improve water quality and wastewater management.

Recommended Reading

Benson, D.; Gain, A. K. and Rouillard, J. J. [2015]. Water governance in a comparative perspective: From IRWM to a 'Nexus' approach?, *Water Alternatives*, 8(1), 756-773.

Matassa, S.; Batstone, D. J.; Hülsen, T.; Schnoor, J. and Verstraete, W. [2015]. Can direct conversion of used nitrogen to new feed and protein help feed the world?, *Environ. Sci. Technol.*, 49, 5247-5254.

Stillwell, A. S.; Hoppock, D. C. and Webber, M. E. [2010]. Energy recovery from wastewater treatment plants in the United States: A case study of the energy-water nexus, *Sustainability*, 2, 945-962

Weitz, N.; Nilsson, M. and Davis, M. [2014]. A Nexus Approach to the post-2015 agenda: Formulating integrated water, energy, and food SDGs, *SAIS Review of International Affairs*, 34(2), pp. 37-50.

Oral Presentations

Improving water quality through an effective implementation of the Water-Soil-Waste Nexus

Sarantuyaa Zandaryaa (UNESCO-IHP) and Fabrice Renaud (UNU-EHS)

- > The presentation will provide a global overview of these problems and will discuss the need for sustainable and integrated approaches to land, soil, waste and wastewater management, including: the need to shift towards a new concept and means of treating and disposing wastewater and waste; and promoting a greater wastewater reuse for nutrient and water recovery and sustainable land and soil management.

Monitoring agriculture – water quality – food safety – health at country level with a Nexus Approach

Sara Marjani Zadeh and Lucie Pluschke (FAO)

- > FAO will present the preliminary results of a nexus study on analyzing the inter-linkages between water quality, agriculture, food safety and health, with AQUASTAT application in five selected countries.

How to manage the implications of the Water-Soil-Waste Nexus on freshwater ecosystems

Janos J Bogardi (Center for Development Research (ZEF)), Fabrice Renaud (UNU-EHS) and Zita Sebesvari (UNU-EHS)

- > Healthy freshwater ecosystems can serve as indicator and guarantee the sustainable water-soil-waste nexus. International guidelines may help to achieve good status for freshwater bodies.

Effect of palm oil mill effluent on the microbial diversity and nutrient dynamics in soil along its discharge course

Geneva Anisiobi, Philip Oviasogie, Napoleon Aisueni and Celestine Ikuenobe (Nigerian Institute for Oil Palm Research (NIFOR)) and Olajire Fagbola (University of Ibadan)

- > Soil pH and all major nutrients except Calcium increased significantly along the course of discharge of palm oil mill effluent (POME). Microbial population was significantly less at the point of discharge than at the settling point.

Poster Presentations

The Sewchar Concept: An innovative tool for a sustainable water – waste – soil nexus of sanitation systems

Marc Breulmann, Manfred van Afferden, Roland A. Müller and Christoph Fühner (Helmholtz Centre for Environmental Research (UFZ))

- > The Sewchar Concept discusses the utilization of chars for human waste and sewage as chars are a strategy for soil amelioration and climate change mitigation, and provide socio-economic and environmental benefits.

Nitrogen compounds and anthropogenic water types in urban groundwater in Yaounde, Cameroon

Robert Kringel (Federal Institute for Geoscience and Natural Resources (BGR)), Andrea Rechenburg (Institute for Hygiene and Public Health) and Marie-Antoinette Fomo (National Institute for Statistics, Cameroon)

- > A high nitrogen load on an urban lateritic aquifer leads to anthropogenic groundwater types dominated by nitrate, ammonium, chloride and sodium in the sub-Saharan capital Yaounde.

Hydrogeochemical evolution and flow mechanisms of groundwater in Yaounde, Cameroon

Dorice Kuitcha, Alain Fouéfé (Institute for Geological and Mining Research, Cameroon), and Robert Kringel (BGR)

- > Rapid seasonal recharge with the isotopic signature of rainwater feeds the lateritic urban aquifer of Yaounde. Anthropogenic input and water-rock interaction control groundwater evolution during fast flow.

Farm-scale anaerobic digestion to support sustainable energy, water and nutrient use: Case study of a UK dairy farm

Jon McKechnie, Alexander Lamond, and Gavin Walker (University of Nottingham)

- > Assessing the role of anaerobic digestion on dairy farms in supporting for waste utilization and reduction of energy and water usage.

S15

REGIONAL LAND-USE DYNAMICS, WATER SECURITY AND THE NEXUS APPROACH

Leading Conveners:

Helmholtz Centre for Environmental Research (UFZ),
Dietrich Borchardt

Co-Conveners:

TU Dresden, Karl-Heinz Feger
UNEP, Thomas Chiramba



In 2050 the world population is predicted to reach 9 billion people that have to be supplied with food and energy as well as clean and safe water. In times of climate change, urbanization and globalization of the economy – especially in emerging and developing countries – population growth implies increasing pressures on natural resources, notably land/soil and water. To ensure food security for an increasing number of people, higher agricultural productivity is necessary. For this purpose a protection of vital terrestrial and aquatic ecosystems associated with a sustainable use of land is very important. The functioning of terrestrial ecosystems plays a key role. Thus, the sustainable management of soil/land resources ensures the provision of a series of water-related ecosystem services.

In order to identify major pressures and impacts on water, Session 15 focused on the regional challenges caused by changes in climate and demography and related land-use dynamics, which in fact are often driven by food production, energy production, industrial uses and human consumptions. The overall goals of this session were the identification of the critical effects of global challenges on natural resources like soil, land, water and waste at catchment scale as well as the conception of sustainable management options in the future, considering the Nexus Approach.

Session 15, jointly organized by the Helmholtz Centre for Environmental Research (UFZ) and the Technische Universität Dresden (TU Dresden), which also cooperate together as part of the Center for Advanced Water Research (CAWR), brought together over 50 international scientists and stakeholders. Six oral and seven poster presentations contributed to the session program. The papers presented in the session focused on contrasting catchments, most of them located in developing and emerging countries (i.e., in Africa and Asia).

The speakers of the session presented case studies from projects reaching thematically from the influence of land-use changes on discharge and water availability in regions with water scarcity, to the identification of trade-offs between ecosystem services, land use and biodiversity under the influence of climate change, as well as techniques for obtaining and analysing data (e.g., remote sensing) in regions with data scarcity and the derivation of information for a sustainable resources management. With regard to data collection, data analysis and hence information generation it was obvious that gaps are still existing in many countries. The session provided also a deeper insight into planning and management strategies and practices (like a multifunctional forestry approach for increasing regional water security) of environmental resources guided by a Nexus Approach at catchment scale. The goals of Day 3 with the topic 'Population Growth and the Increasing Demand for Environmental Resources' as well as the aim of the conference were achieved in this session.

Concluding Remarks / Results of the Session

- There is a necessity for closing the gaps between data collection, information generation (i.e., by modelling) and decision-making, especially in regions where no or little data is available, in order to identify and understand the processes of land-use and climate change and its effects on water, soil/land and waste.
- The provision, understanding, accessibility and use of information by decision makers have to be improved, in order to ensure an implementation of the Nexus Approach at management level.
- The effects of forests in catchments have to be seen in a more differentiated way: The beneficial role of forests/afforestation depends on the placement of stands within the catchment, tree species composition, stand structure and management. Thus, the optimization of hydrological benefits and the establishment of trade-offs with other sectors/ stakeholders need the inclusion of relevant soil-forest stand-atmosphere information.

Oral Presentations

Relative impact of land-use change and climate variability on water yield in the upper Mara River Basin, Kenya

Hosea Mwangi, Karl-Heinz Feger, Stefan Julich (TU Dresden), Gathenya John and Bancy Mati (Jomo Kenyatta University of Agriculture and Technology (JKUAT))

- > Land-use change contributed the majority (97%) of change in streamflow; climate variability contributed the rest 3%. Water resource management efforts should focus on land-use management.

Towards an integrated modelling approach to sustainable management of ecosystems and resilience building in Africa: Understanding the nexus across water, energy, forest and land

Ange-Benjamin Brida (ENVISCIENCES-Environment & Sciences), Alice Bonou (University of Abomé-Calavi), Byron Bester (University of Johannesburg), Prudence Lugendo (Economic and Social Research Forum [ESRF]) and Okoro Sussan (University of Nigeria)

- > New researches for the post-2015 sustainable development agenda in Africa need to take stock of past initiatives while exploring new pathways in the context of global changes and economic growth.

Identifying trade-offs between ecosystem services, land use, and biodiversity under climate change: Combining scenario analysis and optimization to enhance the Nexus Approach

Ralf Seppelt and Martin Volk (UFZ)

- > Trade-off analysis between ecosystem services, land use, and biodiversity offers a possibility to build the synergy for water, energy and food security, and preserving biodiversity on different scales.

Multifunctional forestry as Nexus Approach to minimize the eco-water for regional water security in the dryland regions of China

Yanhui Wang, Pengtao Yu, Wei Xiong, Lihong Xu, Haijun Zuo (Chinese Academy of Forestry), Karl-Heinz Feger (TU Dresden) and Kai Schwarzel (UNU-FLORES)

- > In order to minimize eco-water consumption and to ensure regional water security in the dryland regions of China, multifunctional forestry at scales from watershed are used.

Impact of land use/cover changes on Morogoro River Catchment in the northern slopes of the Uluguru Mountains, Morogoro, Tanzania

Didas Kimaro and Proches Hieronimo (Sokoine University of Agriculture)

- > Poor responses to interventions on environmental conservation exacerbated by soil erosion, particularly landslides, is rampant. The study provides basic data for planning soil and water conservation.

The land-use dynamics and water nexus for the trans-boundary Mekong Basin: Potentials and limitations of Earth observation

Claudia Kuenzer, Patrick Leinenkugel, Corinne Frey, Juliane Huth, Ursula Gessner, Stefan Dech (German Aerospace Center [DLR]) and Marco Ottinger (University of Wuerzburg)

- > This presentation will discuss the results from multi-sensor time series analyses and potential for future collaboration in the Mekong Basin.

Poster Presentations

Infiltration processes in eucalypt and maritime pine stands in Portugal: The role of soil water repellency and preferential flow paths

Filipa Tavares Wahren, Daniel Hawtree, Andreas Wahren, Stefan Julich, Karl-Heinz Feger (TU Dresden), Joao Pedro Nunes, Juliana Marisa Santos and Jan Jacob Keizer (Centre for Environmental and Marine Studies)

- > The importance of soil hydrophobicity temporal dynamics as regulator of infiltration mechanisms are presented in this study. The implications to integrated watershed management are brought to light.

Time-series analysis of the long-term hydrologic impacts of afforestation in the Águeda watershed of North-Central Portugal

Daniel Hawtree, Karl-Heinz Feger (TU Dresden) and João Pedro Nunes (University of Aveiro)

- > This study examines the hydro-meteorological data trends in a Portuguese watershed during a 75-year period of large scale land-cover/use change, and considers the changes in hydrological processes.

Socio-economic factors influencing farmers' adoption of soil and water conservation practices in Morogoro and Ngerengere watersheds, Uluguru Mountains, Tanzania

Dominico Benedicto Kilemo, Karl-Heinz Feger, Stefan Julich (TU Dresden) and Didas N. Kimaro (Sokoine University of Agriculture)

- > The adoption of Soil and Water Conservation practices varies among farmers due to some socioeconomic dynamics. Understanding of these dynamics is crucial for sustainable Watershed Management.

Long-term analysis of regional land-use dynamics in Nigeria using remote sensing data

Babatunde A. Osunmadewa, Christine Wessollek and Pierre Karrasch (TU Dresden)

- > The study shows the results of long-term vegetation analyses based on remote sensing data as contribution for the development of effective sustainable management measures.

Managed aquifer recharge (MAR) index for Asia

Anna-Sophie Strues and Catalin Stefan (TU Dresden)

- > Development of a new tool for overview, analysis and comparison of managed aquifer sites in Asia for better understanding and planning of managed aquifer recharge (MAR) usage in the face of growing water demands.

Earth observation based analyses of land-use dynamics in West Africa

Ursula Gessner, Igor Klein, Kim Knauer, Claudia Kuenzer (German Aerospace Center [DLR]), Joel Arnault and Jan Bliefernicht (University of Augsburg)

- > Earth observation based analyses of West African land-use, vegetation, and surface water dynamics and their interrelations with water availability and population growth.

Convener:

FAO, Lucie Pluschke

As populations and income grow, the demand for environmental resources is increasing globally. The pertinent question is not only how much more food needs to be produced to meet future demand, but how can we better utilise the food that is already being produced?

S16 drew attention to this by highlighting the implications of food losses and waste (FLW). FLW does not only represent a missed opportunity to improve global food and nutrition security, but also an unnecessary use of environmental resources and contribution to climate change. FAO calculated the global blue water footprint of FLW to be about 250 km³, which is equivalent to three times the volume of Lake Geneva. Produced, but uneaten food vainly occupies almost 1.4 billion hectares of land or close to 30 percent of the world's agricultural land area. Intensive farming practices, without allowing fields to lie fallow and replenish, contribute to soil degradation and excessive pressure on soil resources.

First priority should be given to the prevention of FLW, while looking for solutions to reduce losses from primary production, along the supply chain and up to the consumer. For instance, this can be done by improving farming practices, storage, infrastructure, contractual agreements, investment environment, social capacities and raising awareness. At the same time, there needs to be a balance between supply and demand, and making sure that any overproduction can be turned into good use.

Where food losses and waste cannot be prevented, the focus should be on food recovery and commercial/charitable redistribution for human consumption. The environmental footprint of FLW can be reduced by conserving resources throughout the supply chain through re-use (e.g., for animal feed), recycling and recovery through by-product recycling, anaerobic digestion, composting and incineration with energy recovery to allow energy and nutrients to be recovered, representing a significant advantage over dumping the resources in landfills. S16 approached the topic in two ways: 1) by looking at how the impacts of food losses and waste are quantified and assessed; and 2) by presenting current efforts to reduce FLW and to mitigate their impacts.

Assessing FLW and their impacts

Hilke Bos-Brouwers, representing the European FUSIONS Project, explained the goals, scope, system boundaries and type of approach for developing an assessment framework for food waste. Different measurement approaches reveal different costs and, therefore, a startlingly different understanding of the nature of FLW. The main approaches consider loss in terms of weight (tonnes), nutritional value (calories), social impact and economic cost (\$). It is important that indicators to measure FLW are selected wisely and reflect the specific context of steps in the food supply chain.

Detlef Virchow from the Centre for Development Research (ZEF) offered a broad perspective on the topic by looking at the overall efficiency of agro-food systems rather than individual value chains. This system approach – or 'biomass-based value web' – helps to identify where losses and waste of agricultural produce occurs, which can be reused and recycled for other purposes. It not only looks at food products, but also non-food products like animal feed, biofuels and industrial raw materials. At the same time, it allows for an improved understanding of the agro-food system in order to use environmental resources more efficiently and intensify agricultural production more sustainably.

Current efforts to reduce FLW and to mitigate their impacts

Emilie Wieben from FAO provided an overview of global efforts – such as the Zero Hunger Challenge and the SAVE FOOD initiative – to reduce hunger, to promote sustainable food systems and to mitigate climate change by reducing food losses and waste. While interventions should also target individual consumer behaviour, it is important to recognise that there are often underlying structural issues that lead to FLW. This was also stressed by Clementine O'Connor from UNEP, who presented the food waste prevention programme and in particular, her work on capacity building with stakeholders to reduce food waste in South Africa.

The presentations and discussion in the session emphasized that enabling countries and stakeholders to make informed decisions about FLW reduction measures, investments and policies can go a long way. On the one hand it can help reduce social, economic and environmental pressures, and on the other hand ensure food and nutrition security of growing populations.

Oral Presentations

Introduction to the topic of food waste and losses (FLW) and the link to environmental resources

Emilie Wieben (FAO)

- > Causes, socio-economic and environmental impacts; Prioritising impacts : kcal, \$, tonnes; SAVE FOOD initiative

Food use throughout the supply chain: European monitoring framework and environmental impact assessment

Hilke Bos-Brouwers, Karin Oestergren and Silvia Scherhauser (FUSIONS)

- > The FUSIONS project develops a methodological approach to assess environmental impact of food waste throughout EU-28, based on LCA and selected indicator products. This will contribute to harmonisation of food waste monitoring in Europe and reveal significant data gaps for a detailed picture of the environmental impact of European food waste.

How to identify and reduce food loss and waste in a nexus thinking: The biomass-based value web as a novel perspective

Detlef Virchow, Tina Beuchelt, Manfred Denich (Center for Development Research, (ZEF)) and Arnim Kuhn (Institute for Food and Resource Economics (ILR))

- > Instead of the value chain approach, a biomass-based value web is introduced as a multi-dimensional methodology to identify inefficiencies, including food loss and waste, in the entire biomass sector.

Think. Eat. Save. Food Waste Prevention Programmes

Clementine O'Connor (UNEP)

- > UNEP's Think Eat Save campaign raises global public awareness on food waste. UNEP published in 2014 a first of its kind methodology for developing food waste prevention programmes at country, city or company level. The presentation will share first insights from the pilot process in South Africa as well as Think Eat Save's way forward in tackling global food waste.

S17

PROMOTING SAFE AND SUSTAINABLE WASTEWATER USE IN AGRICULTURE: FORMAL AND INFORMAL APPROACHES

Leading Convener:

International Water Management Institute (IWMI),
Pay Drechsel

Co-Conveners:

UNESCO International Hydrological Programme (UNESCO-IHP),
Sarantuyaa Zandaryaa
UNU Institute for Water, Environment and Health (UNU-INWEH),
Mazoor Qadir

S17 consisted of five presentations addressing different aspects of wastewater; the first presentation addressed global and regional dimensions of the status of wastewater treatment and potential for resource recovery and reuse. The second presentation focused on promoting options and approaches for wastewater leading to transitioning from unsafe reuse to safe reuse, based on examples from different countries. The remaining three presentations were country specific, addressing potential health risks from water and soil contamination and indirect use of wastewater in the Nakuvibo wetland swamp in Kampala, Uganda; options for producing treated wastewater for agricultural applications in Mauritius; and the trajectory of

a successful story of formal use of treated effluent in Western Cape Province in South Africa. The country-specific presentations were given by doctoral students.

The session largely achieved its objectives through the presentations and follow-up questions, comments and active participation of the audience. The major message reflected on limited availability of wastewater related data to be used to set specific baseline and subsequent monitoring of the progress related to SDG target 6.3 *'By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and at least doubling recycling and safe reuse globally.'*

Currently, the potential for resource recovery from wastewater is largely untapped and only a small portion is used in a planned and safe manner. Considering the current status of wastewater treatment in low-income countries, interim strategies are needed while full capacity wastewater collection and treatments systems are developed. Based on the presentations and discussions in the session, there are solutions available to transform unsafe use of wastewater into safe use in a productive manner through risk management such as sanitation safety plans, reuse-specific wastewater treatment, awareness raising, institutional arrangements, farmers' involvement and supportive policies, among others.

The session contributed to the aims of Day 3 of the conference through linking population growth and urbanization to the production of greater volumes of wastewater in urban and peri-urban settings. As volumes of wastewater are expected to increase further with the population growth and urbanization, there is an opportunity for harnessing the potential of wastewater as a water, organic matter, nutrient and energy resource based on better management options stemming from resource recovery and reuse.

Considering the fact that global change will put additional pressure on environmental resources and related ecosystem services as well as on economic development, the topic of the session also addressed best management practices for maintaining and enhancing environmental resources by adopting the Nexus Approach to the sustainable management of water, soil and waste. Wastewater management has a key place in the Nexus Approach as it is closely linked with other pillars of the nexus. There is a need for a paradigm shift from 'treatment for disposal' to 'treatment for reuse' through harnessing its potential for reclaiming potable water, aquifer recharge, sustainable implementation of aquaculture and agroforestry, and the support of various ecosystem services. The key conclusion/recommendation of the session was that the society at large does not have a choice – *we cannot afford wasting wastewater as this is a valuable resource of water, organic matter, nutrient and energy.*

Oral Presentations

Setting the scene: Status of wastewater treatment and potential for irrigation

Manzoor Qadir (UNU-INWEH) and Javier Mateo-Sagasta (IWMI)

- > While a small portion of wastewater in low income countries is treated, informal use of untreated wastewater in these countries is common, posing significant potential health and environmental risks.

Wastewater reuse: Options and approaches to transitioning from unsafe reuse to safe reuse

Sarantuyaa Zandaryaa (UNESCO-IHP)

- > The presentation will discuss the need for an integrated and holistic approach for urban water management.

Potential health risks from water and soil contamination and indirect use of wastewater in the Nakuvibo wetland swamp in Kampala, Uganda

Samuel Fuhrimann, Cissé Guéladio, Mirko Winkler (University of Basel) and Kate Medicott (WHO)

- > A comprehensive assessment of the wastewater and soils nexus in Kampala, Uganda, along with a trial process of a Sanitation Safety Planning to facilitate the step-by-step implementation of the WHO guidelines will be presented.

Options for producing treated wastewater for agricultural applications: The Mauritius case study

Solomon Gebrechorkos, Mari Ito and Hiroshan Hettiarachchi (UNU-FLORES)

- > Alternative wastewater treatment options are examined, considering the quality of treated wastewater produced, safe use for crops (food, non-food and industrial), applicability and key lessons, based on the case in Mauritius.

'If opportunity doesn't knock, build a door': The trajectory of a successful story of formal use of treated effluent in Western Cape Province, South Africa

Cecilia Saldias, Stijn Speelman and Guido Van Huylenbroeck (Ghent University)

- > Formal and safe use of treated waste in agricultural irrigation is possible when a proper regulatory framework, economic incentives and market drivers are in place.

Poster Presentations

Assessment of constructed wetlands for the treatment of wastewater for peri-urban irrigation in Kenya and Mozambique

Bancy Mati (Jomo Kenyatta University of Agriculture and Technology), António Cumbane (Eduardo Mondlane University), Mahesh Jampani, Mari Ito and Hiroshan Hettiarachchi (UNU-FLORES)

- > This poster shows proposal for constructed wetlands (CWs) for wastewater treatment for agricultural use in peri-urban Isiolo town of Kenya. CWs are ponds planted with special aquatic plants, which utilize natural processes to treat wastewater.

Application of bioaugmentation for safe and sustainable reuse of wastewater: Case studies in Namibia and Ethiopia

Elsabe Julies (University of Namibia), Araya Alemie Berhe (Mekelle University), Mahesh Jampani, Solomon Gebrechorkos, Mari Ito and Hiroshan Hettiarachchi (UNU-FLORES)

- > This study focuses on removal of hormones and nutrients through bioaugmentation to allow safe use of treated domestic wastewater in Ethiopia and Namibia.

Nexus Approach in urban-agricultural system: A study of a small island

Indra Firmansyah, Marc Spiller, A.L. Smit, Gerrit-Jan Carsjens and Grietje Zeeman (Wageningen University)

- > This study applied Nexus Approach in urban-agricultural system of a small island by recovering water and nutrients from wastewater and reuse in agriculture.

Local solutions to multiple water and agriculture problems in rural community in Armenia

Arevik Hovsepian, Zaruhi Khachatryan (Country Water Partnership NGO) and Eduard Mesropyan (JINJ Ltd.)

- > Within the Parakar village of Armenia, a wastewater treatment plant was built with innovative approach to rehabilitate degraded agricultural land and provide additional irrigation water and income for residents.

Leading Convener:

Center for Development Research (ZEF),
Christine Füst

Co-Conveners:

Leibniz University of Hanover,
Christina von Haaren and Christian Albert



S18 was dedicated to providing an overview and discussion on the potentials and limitations of integrated land-use planning approaches and of the ecosystem services (ES) concept in regional planning. Overall, there were eight presentations and four posters that addressed case studies in European and international contexts. We focused on the following application areas:

- ES in regional participatory planning and decision-making processes, including cross-boundary aspects
- integrating spatial and temporal variability in ES provision in regional planning, and how to use ecosystem services to assess trade-offs from increased bioenergy provision demands
- payments for ecosystem services (PES) as a tool to coordinate land-use and land-cover changes

The session provided a broad overview of current trends in further developing the ES concept as an integrative framework to guide planning processes and consult environmental policies towards achieving the UN Sustainable Development Goals. Different from the questions that were raised for Day 3, our presentations provided a regional or global perspective and didn't exclusively focus on agricultural systems. From our discussion, we learnt that the Nexus Approach and ES in integrated land-use planning are relatively similar concepts. Integrated planning approaches are more concrete on how to break down the interactions and feedback loops between the human world and bio-geosphere to solve concrete problems of resource distribution. Both can be seen under the larger umbrella of Social-Ecological System Science that provides a holistic concept on how different disciplines, scales and actors need to cooperate to achieve a full understanding of opportunities and critical thresholds in population growth.

Conclusions of our sessions were, that particularly a stronger participation of local and regional actors is needed – in research and planning practice – to identify best opportunities for sustainable development; it is absolutely essential to include local and indigenous knowledge and constraints – a purely global view runs the risk of being dominated by big players in the Global North and to exclude solutions in favour of demands from the Global South. Co-design and co-development of integrative concepts such as the Nexus Approach or integrated land-use planning and impact assessment should, therefore, be taken more seriously. Improved feedback processes between policy and decision makers at different scales and research are needed. This requires developing a common language or ontology that facilitates the communication between science and policy.

Integrated land-use planning, ES as assessment framework or the Nexus Approach can only provide a blueprint how a sustainable future could look when an equitable access to resources is considered including intergenerational equity. Solving the problems of population growth and poverty is more a question of access to education, critical knowledge and of showing perspectives within a given cultural context. Cultural constraints might be much more decisive for poverty than population growth as such. Neither the Nexus Approach, nor integrated planning and ES can solve, for instance, the problem of gender or ethnic differences in the access to resources, education or markets.

Here, approaches that show what kind of social innovation could help to overcome the problem of poverty are requested. The challenge is how to make them part of integrated planning processes or nexus concepts.

Though population growth in underdeveloped countries is often perceived as a problem, we ignore the fact that it provides one essential 'service' on a very high level: human capacity that is indispensable to turn natural resources into living resources. This human capacity does not only consist in working power, but much more in intellectual power that is so far greatly underexploited. A globally networked world cannot renounce on any intellectual resources that we need to ensure a sustainable ecological, social and economic development. 'Appropriate education' and 'intellectual power' do not necessarily mean that concepts and knowledge from the Global North are transferred 1:1 to less and least developed countries.

In contrast, social behaviour, learning and community interactions are key aspects in the resilience of Social-Ecological Systems in the Global South that could be taught to the Global North. Here, mutual 'sustainability learning' would be a success factor that might also teach developed countries how to overcome problems of overaged populations.

Oral Presentations

Integrated modelling, mapping and assessment of ecosystem services: Challenges and approaches

Christine Fuerst (Bonn University), Susanne Frank (ZEF), Katrin Pietzsch and Frank Pietzsch (PiSolution GmbH)

- > Data and information bases are not sufficient to assess and map ES for EU Biodiversity Strateg. T.2 and IPBES. There is a fundamental need for integrative modelling to provide decision and policy support.

Integrated land use strategic planning of peripheral region: Case study from Czech-Polish borderland labor market

Marcin Spyra (Opole University of Technology), Jan Bondaruk and Anna Pilch (Central Mining Institute)

- > The Nexus Approach for integrated land use planning in peripheral regions is discussed as the replication of the proposed methodology in other peripheral regions could be straightforward.

How combining land-use change simulation and ecosystem services assessment can support integrated land-use planning

Susanne Frank, Christine Fuerst (ZEF) and Frank Pietzsch (PiSolution GmbH)

- > GISCAME facilitates integrated assessment of land management at the regional scale. Energy crops and fuel wood production can be increased without consuming land. Trade-offs must be considered.

A case for landscape planning and governance: Balancing trade-offs between bioenergy and other ecosystem services

Christian Albert, Johannes Hermes, Felix Neuendorf, Carolin Galler, Michael Rode and Christina von Haaren (Leibniz University of Hanover)

- > Trade-offs between bioenergy production and other ecosystem services are spatially assessed and quantified. Targeted spatial planning and governance options for balancing trade-offs are proposed.

Experiences from Payments for Ecosystem Services for reducing Deforestation and Forest Degradation

Gerald Kapp (TU Dresden) and Leonel Iglesias (The World Bank)

- > Important lessons learned from PES and Conservation Incentive Programs can inform the forest conservation programs of tropical countries, specifically for the so-called national REDD+ Programs.

Participatory impact assessment of improved Food Value Chains: The case of semi-arid Dodoma region in Tanzania

Hannes Koenig, Jana Schindler, Frieder Graef, Stefan Sieber (Leibniz Centre for Agricultural Landscape Research (ZALF)), Laurent Kaburire (Mtandao wa Vikundi vya W akulima Tanzania (MVIWATA)), Devotah Mchau (Agriculture Research Institute (ARI)), Khamaldin Mutabazi and Henry Mahoo (Sokoine University of Agriculture)

- > This presentation will look at food value chains in rural Tanzania as stakeholder participation and expert knowledge is combined and participatory impact assessment is used to support identifying and implementing alternative upgrading strategies.

Expert-based assessment of land-use scenarios in northern Ghana

Janina Kleemann, Christine Fürst, Güleandam Baysal, Hongmi Koo and Justice Inkoom (ZEF)

- > Bayesian Belief Networks can be used to model socio-ecological interactions, allow the integration of local knowledge and help to explore the system behavior under different scenarios.

A stakeholder-based approach for assessing agricultural land-use scenarios on ecosystem services in Northern Ghana

Hongmi Koo and Christine Fürst (ZEF)

- > A stakeholder-based assessment considering human-ecosystem relations helps to balance place-specific and overall targets for developing successful planning scenarios.

Poster Presentations

Temporal dynamics of biomass products provision at the landscape scale

Marcos Jiménez Martínez (University of Bonn) and Christine Fürst (Center for Development Research (ZEF))

- > Evaluation of the production potential of rural areas requires an integrated assessment of land use types with different rhythms of productivity and a diverse range of product types as yield.

Subterranean spatial planning – sustainable solutions to conflicting use in the subsurface: Challenges and opportunities

Sebastian Bartel and Gerold Janssen (IOER)

- > The frequency and range of subterranean interventions is set to increase. Therefore accepted spatial planning techniques must be applied to the exploitation of the subsurface.

Evaluation of the impact of payments for reforestation in the Mexican State Michoacán

Elsa Maria Cardona Santos, Karin Holm-Müller and Daniel Kyalo Willy (University of Bonn)

- > Our study reveals a lack of additional reforestation payments in Mexico due to leakage and decreased reforestation in non-targeted areas, which should be addressed in future PES schemes.

Indicators of hemeroby for land-use monitoring in Germany

Christian Stein and Ulrich Walz (IOER)

- > Hemeroby indicators measure the human impact on natural environment. Regular calculation could make a significant contribution to the qualitative description of settlement and open space development.

CONCLUDING TALK OF THE DAY

Timothy O. Williams

International Water Management Institute,
Director of Africa



Photo: R.Vigh/IOER.

Population growth and the increasing demand for environmental resources: challenges and opportunities

The world's population reached 7.2 billion in 2013. By 2050, it is projected there will be 9.6 billion people on Earth (UNDESA, 2013). Half of the 2.4 billion increase in population will occur in sub-Saharan Africa (SSA), where in 2014 one in four people remained malnourished (FAO, IFAD & WFP, 2014). At the same time, urbanization is growing apace. In 2014, 54% of the world's population lived in urban areas, with this proportion projected to increase to 66% by 2050. Although all regions of the world are expected to urbanize over the coming decades, Africa and Asia are urbanizing faster and are projected to become 56% and 64% urban, respectively, by 2050 (UNDESA, 2014). Identifying ways to feed this burgeoning population, while enhancing the livelihoods of farmers and simultaneously protecting valuable ecosystems is one of the daunting challenges currently facing the world. The multiple dimensions of this challenge impinge on the nexus of water, soil and waste.

Challenges

There are four dimensions to the challenge posed to humanity and environmental resources by population and urbanization growth. These include a demand challenge; an access challenge; a waste, pollution and resource quality challenge and a supply challenge.

Population increase will lead to soaring demand in food. FAO estimates that 60% more food will be needed to feed the over 2 billion people that will be added to the world's population by 2050 (Alexandratos and Bruinsma, 2012). This will entail about 20% increase in agricultural water consumption by 2050, this comes on top of the current 70% global water withdrawal by the agricultural sector.

In many parts of Sub-Saharan Africa and South Asia, slow progress has been achieved in improving access to food due to high poverty rates, sluggish income growth, high and volatile food prices and poor rural infrastructure, which hampers physical and distributional access. This implies that the world will need to close the food gap in ways that will also enhance economic development and livelihoods of poor rural urban and dwellers.

With regards to waste, pollution and resource quality challenge, many of the papers presented today in the parallel sessions touched on this subject. There is food waste that represents also a waste of environmental resources. In addition, there are solid and liquid wastes that end up polluting surface and ground water and soils, especially in developing countries.

Meeting future demand for food would require a big increase in supply. Water and land are likely to present the greatest challenges on the food supply side, given the dwindling availability of arable land and water resources in many parts of the world.

Opportunities

The challenges highlighted above are not insurmountable. Through a mix of technical improvements, appropriate policies, economic incentives and institutional reforms, increased resource productivity can be achieved to increase food supply and enhance economic growth. The same forces can be unleashed to reduce waste and pollution while ensuring sustainable use and management of environmental resources. Science and technology and access to markets can help to reduce food waste and increase yields. New efficient irrigation technologies, such as, drip and sprinkler irrigation, plus better agronomic and soil management practices can lead to improved water-use efficiency. Increased use of solar and wind power in pumping water for irrigation will reduce dependence on fossil fuels that are now traditionally used. If irrigation is combined with the full suite of crop enhancement inputs – organic and inorganic fertilizers and pesticides – yields per hectare will increase. Science-based land management practices that incorporate indigenous knowledge coupled with policies to tackle anthropogenic factors that contribute to land degradation can help to reduce land degradation. As László Miklós pointed out in his keynote speech, integrated planning and management of environmental resources will be needed but this will require changes in institutional structures and mind sets. An opportunity that must not be missed concerns population management, especially in developing countries. While this subject is sensitive, it needs to be addressed in a pragmatic and culturally feasible way to ensure that this important component of the solution set is not neglected or forgotten.

Conclusion

The challenges and opportunities briefly presented above represent an action research and policy reform programme for the proponents of the water, soil and waste nexus. In the context of the post-2015 development agenda on Sustainable Development Goals (SDGs), developing countries will be challenged to effectively manage water, soil and other environmental resources to provide food and economic development without jeopardizing environmental security objectives. Science-based indicators will be needed to help these countries monitor and evaluate their performance and progress made towards achieving the SDGs and targets. Now is the time to move beyond concepts to begin to work on relevant indicators that can be used to monitor and evaluate the significance of the water, soil and waste nexus in the context of the SDGs.

References

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PANEL DISCUSSION

Moderator	Danka Thalmeinerova, Global Water Partnership, Senior Knowledge Management Office
Panelists	Thanasius Sitolo, Malawi Ministry of Agriculture Irrigation and Water Development, Principal Community Water Supply and Sanitation Officer Sebastiao Famba, Mozambique Universidade Eduardo Mondlane, Assistant Lecturer on Irrigation, Drainage and Hydrology
	Lead Conveners from S12, S13, S14, S15, S16, S17 & S18



CONCLUSION AND OUTLOOK

CLOSING REMARKS

Verena Klinger-Dering

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



Photo: R.Vigh/IOER.

Thank you indeed for the invitation and for the opportunity to make some closing remarks on behalf of the German Federal Environment Ministry here today. First of all, already now my sincere congratulations for this very successful conference, for inviting and attracting so many representatives from the scientific community all over the world to the beautiful city of Dresden and for focusing on the nexus perspective. This is a key issue for the German Government since the Federal Environment Ministry together with the Federal Ministry for Economic Cooperation and Development dedicated an international conference to the Nexus in 2011.

Looking back on the past three days, I can confirm from the plenaries and sessions in which I participated that there were very rich discussions with lively interactions and many important messages. We can see that a lot of work has been done on the Nexus Approach since the Bonn 2011 Nexus Conference – which marked the starting point of the discussions on the importance to address the interlinkages between sectors and highlight their possible

mutual benefits – thanks to the commitment and actions of many actors, amongst them today's conference. However, a lot still needs to be done.

I would very much like to briefly comment on just three main challenges and messages from this conference that struck me, and later on, I would like to briefly point out where we stand with our nexus activities. The first message I would like to point out was the call of several speakers for taking a systems view of the challenges. This is very crucial. There is an increasing complexity of the issues on the global level that needs to be untangled. We definitely need to better understand the diverse linkages, the drivers, the trade-offs and the opportunities between the different sectors and thus to enable decision makers to take better informed decisions, be it government, be it industry or other actors. It is clear that one part of the solution will be to improve the knowledge platform, increase knowledge transfer and strengthen capacity building. The main partner for the government is the scientific community; UNU-FLORES and Technische Universität Dresden are outstanding examples of this partnership.

The second message of the conference that I would like to stress is the pressing need for a comprehensive solution. Indeed, complex problems, such as those we are facing, need complex solutions. There is no need to simplify, there is no one-size-fits-all solution for global issues, but rather we need multi-level, cross-sectoral solutions that are tailored to the specific needs of the people on the regional and municipal level. This is a comprehensive governance task that we will not manage to do with the active participation of all stakeholders at an early planning stage.

And this brings me to the third and last message I would like to stress, which was the call of several participants for engaging the human dimension. Today's problems cannot be solved by technology or science alone. They are instead human problems of governance, leadership and social resilience. Sustainability is a collective issue that demands collective solutions with the involvement of the individuals. It will be crucial to build social capacity to face the challenges through participatory action, empowerment of women or linking traditional indigenous know-how with modern scientific and technical approaches.

Having these three challenges in mind, the nexus perspective is from our point of view a viable tool to give proper guidance. But the elephant in the room is still how to bring the nexus on the ground. For national governments, the role is to create the necessary political framework and to fill the critical gaps for its implementation. In Germany, we are proceeding twofold: On the one hand, we are about to integrate the nexus idea in our national environment strategy. The next step will be to integrate the nexus into our national sustainability strategy, which covers all political sectors. But for now the main focus lies on the international activities, on regional level and UN level in the framework of the post-2015 negotiations, including a new set of Sustainable Development Goals for the next 15 years to be adopted in September this year.

Germany has actively supported the negotiations and the works of the open working group on a proposal that is now on the table and which contains a dedicated goal for water and other water relevant references in other goals, such as the SDG for health, sustainable consumption and production, citizen and human settlements, ecosystems and oceans. We now focus on the elaboration of a robust review-mechanism based on a set of indicators to make sure the targets are properly monitored and the progress made is properly assessed. We are involved in these processes on UN level, including in activities to improve the collection and the dissemination of data in the area of water quality. Since April 2015, Germany has hosted a global water quality monitoring program of the UN, called GEMS Water in Germany, which can play an important role in the future regarding the monitoring of a possible water quality indicator.

This brings me to my last point, which is the crucial role academia plays in the SDG process as a think tank and with its interdisciplinary institutions, like UNU-FLORES, the Technische Universität Dresden and the Leibniz Institute of Ecological Urban and Regional Development. These are important partners for the government. But it is the whole global scientific community that is at the core of sustainable development. Your work in your areas of capacity attribute to the capacity building and knowledge transfer that is indispensable for achieving sustainable development. We count on all of you and thank you for taking the decision to participate today in this conference. Thank you for your attention..

CONFERENCE WRAP-UP TALK



BEYOND DNC2015

Rattan Lal

Ohio State University,

Distinguished University Professor of Soil Science and Director of the Carbon Management and Sequestration Center

Article based on the speech and prepared by the speaker given at the closing of DNC2015.



Photo: R.Vigh/IOER.

The 68th UN General Assembly (A/RES/68/232) declared 2015 the 'International Year of Soil' (IYS). Among the principal objectives of the IYS are to: (i) create full awareness of civil society and decision makers about the fundamental roles of soils for human life, (ii) advance full recognition of the prominent contributions of soils to food security, climate change adaptation and mitigation, essential ecosystem services, poverty alleviation and sustainable development, and (iii) promote effective policies and actions for the sustainable management and protection of soil resources. In this context, some of the objectives of DNC2015 are in accord with those of the IYS and Sustainable Development Goals of the U.N.

The Anthropocene

The topsoil, 0-30 cm depth, has been profoundly transformed by humans. The magnitude of the impact or I ($I = PAT$; Ehrlich and Holdren, 1971) depend on the population (P), affluence (A) (materialism and greed) and the technology (T) based on knowledge and scientific advances. Humans are both product (as being of) and part of (in) nature. The era in which the anthropogenic impact on Earth is equivalent to that of any geologic force, called the 'Anthropocene', may have begun thousands of years ago with the on-set of settled agriculture (Ruddiman, 2003) rather than with the Industrial Revolution of 1750s (Steffen et al., 2007).

The Nexus Approach

The Nexus Approach, or inter-connectivity of processes, has been emphasized in many ancient cultures. The Nexus Approach is pertinent to addressing numerous global issues including: (i)



food-energy-water (Finley and Seiber, 2014), (ii) food-water nexus and irrigation water quality (Gelting and Baloch, 2012), (iii) water-energy nexus (Scott et al., 2011), and (iv) water footprint and virtual water (Velazquez et al., 2011). In ancient India, Kautilya's Arthashastra, composed around 300 BC, describes economics, politics, war science and agriculture. Kautilya proposed that along with agricultural activities, the State should also sponsor activities in development of forests for elephants and other wild animals, pasture lands, and also marketing and transportation and communication facilities. Kautilya observed that development of all these fields is interrelated and interdependent. Thus, he advocated that a holistic approach is necessary, and that a single activity cannot properly flourish in isolation.

In China, Lu's 'Spring and Autumn Analects', composed around 239 BC, observed that soil fertility could be increased or degraded by different practices, such as tillage. A book written during the Ming Dynasty *Nongshou* composed by Yilong Ma also observed the relation between deep tillage and root system development, and that properly managed soils could sustain higher plant density and per area productivity (Harrison et al., 2010). The seed drill, pulled by draft animals, was developed by Sumerians around 1500 BC and also used by the Chinese around the same period. Jethro Tull, an English economist, is credited with designing the modern mouldboard plough and the seed drill around 1601 (Harrison et al., 2010). It is important to note that most ancient cultures emphasized technology that worked, rather than scientific processes and mechanistic understanding of the underlying reasons.

Naturalist John Muir (1838-1914) observed that, 'When we try to pick out anything by itself, we find it hitched to everything else in the universe'. Barry Commoner (1971) outlined four Laws of Ecology including, the first being, 'Everything is connected to everything else'. Marcus Terentius Varro (116-27 BC), a Roman philosopher, defined sustainable agriculture, 'Est scientia, quae sint in quoque agro serenda ac facienda, quo terra, maximos perpetuo reddat fructus' (Agriculture is a science, which teaches us what crops are to be planted in each kind of soil, and what operations are to be carried out, in order to that land may produce the highest yields in perpetuity). Similar concepts on sustainability have been proposed in China (Shennong, 2737-2699 BC), India (Krishi Parashar, 4th century AD), and Arab countries (Ibn-Al-Awan, a Spanish Moore from the twelfth century).

The Nexus Approach and global issues

The concept of ecosystem services (Daily, 1997) emphasizes goods and services of relevance to nature conservancy. Humans, being a part of nature, impact provisioning of goods and services in managed ecosystems. To be sustainable, therefore, whatever humans do must profit nature. Ecosystem services provisioned by natural and managed ecosystems include food, water renewability, biodiversity, carbon sequestration, climate moderation and so on.

The Nexus Approach is also relevant to addressing global climate change. Humans have not had to deal with such a drastic climate change since 10 to 12 millennia ago. With a population of 7.3 billion in 2015 and projected to be 9.6 billion by 2050, humans have to address climate change and increasingly so, in the future. This is where the Nexus Approach can be extremely pertinent. Whereas the projected adverse impacts of climate change are well known and widely recognized (IPCC, 2014), there may be a silver lining in the ever darkening cloud of climate change. Indeed, humanity cannot afford to overlook any opportunities that may also arise from changing climate, shifting biomes and altering species. Losers and winners will involve those who ignore or seek new opportunities that may come along. These opportunities can be identified and harnessed by following the Nexus Approach.

The Nexus Approach is also relevant to achieving the UN SDGs (Bouma, 2014). Being the engine of sustainability, achieving SDGs necessitate that soils are the basis of economic/ecological development. In addition to achieving net land degradation neutrality (Lal et al., 2012a), it is also pertinent to focus on achieving zero net CO₂ emission through recarbonization of the biosphere.

Recarbonization of the biosphere

The terrestrial biosphere has lost about 500 Gt of C since the onset of settled agriculture (320 Gt from the pre-historic era to 1750, 136 Gt from 1750 to 2010 and 30 Gt from 2010 to 2030; Ruddiman, 2005; Holdren, 2008), part of which can be re-sequestered through strategies of recarbonization of the biosphere (Lal et al., 2012b). In addition, the Nexus Approach can also be useful in developing a strategy of equitable allocation of the so-called C-pie of the fossil fuel use to limit the temperature increase to 2 degrees Celsius.

Global soil organic carbon (SOC) pool to 2-m depth is estimated at about 2400 Gt (Batjes, 1996). Increasing SOC pool by 1% (24Gt) can decrease atmospheric concentration of CO₂ by about 11 ppm (1 Gt= 0.47 ppm of CO₂; <http://cdiac.ornl.gov/phs/convert.html>). While the C sink capacity of the terrestrial biosphere is finite (1-2 Gt C/yr for ~50 year), it is the most cost-effective option with numerous co-benefits. Furthermore, restoring soil quality by improving the SOC concentration to above the threshold level (1.1 to 1.5% by weight) is essential to human well-being and nature conservancy. Global hotspots for recarbonization of the biosphere and protection of the existing ecosystem C stocks are: (i) northern latitudes comprising boreal and tundra climates, (ii) tropical regions approximately 23 north and south of the Equator, and (iii) the Himalayan-Tibetan ecosystem or so-called the 'Third Pole.'

There are numerous techniques of recarbonization of the soil and vegetation, but there exists neither a panacea nor a silver bullet. Furthermore, each of these options has trade-offs. We cannot afford to be myopic and locked into a specific strategy, and must look for multiple paths. The strategy is to identify soil/site-specific options that can create a positive ecosystem carbon budget, are cost-effective and adaptable under physiographic and socio-economic conditions. Conversion of biomass-carbon into humus requires additional nutrients. Thus, farmers must be appropriately compensated as payments for ecosystem services provisioned (Lal, 2014).

Urbanization and world population

The world population is increasing at the rate of about 75 million per year (UN, 2012). By 2050, as much as 70% of the world population will live in urban centers. At this rate of growth, urbanization is encroaching upon prime farmland at the rate of ~3 million hectares per year (Lal and Augustin, 2011). At present, there are 236 cities in the world with a population of ≥10 million. A city of 10 million requires 6000 tones of food a day. Thus, it would be prudent to grow as much food in the vicinity of urban centres as possible, by using grey water in conjunction with sky farming techniques and other innovative systems of urban agriculture. The soil-less culture (aquaponics, hydroponics, aeroponics etc.) can also be useful in space-related agriculture. Growing food within urban centres using soil-less culture is another strategy of saving the finite soil resources for other essential ecosystem services and nature conservancy.

Improving agro-ecosystems with the Nexus Approach is also relevant to alleviating poverty, because there exists a close relationship between soil quality and farm income (Lal, 2008).

The Need for action

The UNU-FLORES is at a crossroads. Since its inauguration on 10 December 2012, it has made phenomenal progress in understating the principles and benefits of the Nexus Approach in addressing issues of global significance (e.g., climate change, population, urbanization, food security, energy and water demand). These issues must be prioritized, and an action plan implemented at benchmark locations. Criteria must be developed for selection of appropriate benchmark sites.

The strategy is to translate knowledge about the Nexus Approach into action. In this context, implementing training programmes and education of stakeholders at all levels can be strategically critical.

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EXHIBITION HALL

The Exhibition Hall, open during the entire conference, was a popular location during lunch and coffee breaks. Participants eagerly took the opportunity to engage with the international, regional and local institutions that showcased their work and research.

The following institutions were on display:



SUMMARY & OUTLOOK

DNC2015 took place under the umbrella of 'Global Change, SDGs and the Nexus Approach'. Global Change, in all its forms, is possibly the most pressing challenge humanity faces in the twenty-first century. To address this challenge, the international community has devoted much time and effort into identifying the Sustainable Development Goals (SDGs), but concrete strategies for achieving these goals are still in development. Focusing on three key dimensions of global change – climate change, urbanization and population growth – conference attendees discussed how adopting a Nexus Approach can help develop effective and appropriate strategies for implementing these goals. The presenters in the parallel sessions, the panel discussions and the keynote speakers were in consensus on one point: applying a Nexus Approach is one of the keys to identifying effective and appropriate mechanisms for achieving the SDGs. Given that the process towards SDGs is only about to start, this issue will surely be taken up in forthcoming DNCs.

A recurring – and related – theme during sessions and panel discussions at DNC2015 was the emphasis on the human dimension of the Nexus Approach. This dimension has various facets: stakeholder involvement, livelihoods of the people (e.g., smallholder farmers, rural communities) and governance issues. Including and considering such aspects must be part of the required systems-thinking concerning the Water-Soil-Waste Nexus.

A further conclusion of the conference is the central role of the Water-Soil-Waste Nexus in achieving sustainable development and food security, particularly with regard to the pressing challenges posed by the ever-growing global population. 'The train that is going to bring us a total global population of 9.6 billion people by 2050 has already left the station. We cannot stop it. Our task is to be prepared to receive these guests,' Professor Rattan Lal emphasized in the conference wrap-up talk. Soil, in particular, plays a critical role in ensuring the means of existence for all global citizens. Maintaining the integrity of soil (again emphasizing ecosystem services), but also exploring soil-less or less soil-intensive means of agriculture will be crucial.

Finally, organizers, stakeholders and participants alike agreed that it is time to translate collective knowledge and collective goodwill into action. Developing and adopting a Nexus Approach will increasingly gain momentum when more and more case studies implemented at benchmark locations are available to demonstrate the benefits of adopting integrated resources management plans. A critical step in implementing nexus management strategies is to develop educational curriculum that applies and promotes integrated thinking. Educational programmes need to be executed in an integrated, cross- and transdisciplinary manner, and at the same time teach critical integrated thinking.

As UNU-FLORES Director Reza Ardakanian summarizes, 'the successful implementation of the integrated management of environmental resources requires a nexus mind-set. If the people on the ground are resistant, nexus strategies will not work. Educational, study and knowledge sharing programmes are the first step to addressing this gap.' Professor Bernhard Müller, Director of IOER, drew attention to open-ended questions with regard to the implementation of the nexus approach, 'the theoretical foundation needs further research and it needs to be asked, how integrated thinking can successfully respond to resistance.' Addressing this is an important task for the DNC team (UNU-FLORES, TU Dresden and IOER).

In the initial follow-up to DNC2015, the organizers have emphasized the importance of continuing the constructive discussions that emerged beyond the conference. In this vein, they have taken steps to facilitate these discussions by providing access to the content of the conference through multiple channels and mediums.

- **The Dresden Nexus Conference Playlist:** Launched on YouTube and open to the public, this playlist comprises full-length videos of plenary sessions. All keynote speeches, panel discussions, concluding talks and opening and closing remarks are gradually being made available for viewing.
- All **DNC2015 Presentations** have been compiled and put online at dresden-nexus-conference.org/documents-2015.html.¹
- And finally, by providing written summaries of all sessions at DNC2015 this volume, ***State of the Nexus Approach 2015: Management of Environmental Resources***, functions as a survey of current research projects and initiatives concerning the Water-Soil-Waste Nexus.

In addition, the organizers have collected and analysed feedback from participants. This valuable input will be used to develop the programme for DNC2017 and to ensure that future DNC events will continue to address the most pressing topics for researchers and practitioners of the Nexus Approach.

Reacting to the outcomes of DNC2015 and the focus of nexus-related initiatives, the organizers have decided that the SDGs will continue to provide a general framework and guideline for future DNCs. It was clearly demonstrated that adopting a Nexus Approach is instrumental for achieving SDGs, and future DNC activities will take up this discussion. As the Water-Soil-Waste Nexus is at the core of the DNC concept, how the Nexus Approach is fundamental to successfully reaching these goals will be illustrated by showcasing initiatives and research that revolve in particular around on the SDGs addressing food security and sustainable agriculture (SDG 2), sustainable management of water (SDG 6), energy security (SDG 7) and resilient and sustainable settlements and cities (SDG 11).

The process of defining the topic(s) of DNC2017 is underway and will involve both returning and new key stakeholders from the relevant sectors and disciplines. DNC2017 will strive to put more emphasis on the process and procedures of implementing a Nexus Approach. At the next conference, the organizers aim to provide innovative and educational case studies that show the nexus in practise and provide working examples of how a Nexus Approach can facilitate sustainable development.

¹ For information on how to access the presentations, please contact DNC2015@unu.edu.

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Fluxes and of Resources

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Ecological Urban and
Regional Development

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