# Managing the climate-water-forest nexus for sustainable development

## Are we on the right track?

**12 November 2015,**
**Hof van Wageningen Conference Centre**
**Wageningen, The Netherlands**

*'Managing the climate-water-forest nexus for sustainable development' was organised by Tropenbos International, with Wageningen University and Research Centre (WUR), Utrecht University, the Dutch Society of Tropical Forests, the Netherlands Ministry of Economic Affairs and Ministry of Foreign Affairs.*

*The meeting was chaired by René Boot, Director of Tropenbos International. Speakers and panel members included Hubert H.G. Savenije (TU-Delft), Douglas Sheil (NMBU), Sampurno Bruijnzeel (King's College London), Jelle Behagel (WUR), Julie van der Bliek (IWMI) and Jan Willem den Besten (IUCN NL).*

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Seminar photographs by Harry Wilcken.

This is the ninth in a series of annual seminars on ***Sustainable forest management in the tropics. Are we on the right track?*** This year it is jointly organized by Tropenbos International, Utrecht University (Prince Bernhard Chair), Wageningen University (Forestry groups, Centre for Development and Innovation), the Dutch Association of Tropical Forests (VTB), and the Ministry of Economic Affairs and Ministry of Foreign Affairs of the Dutch government.

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## Summary

"We know about the interrelation between climate, water and forests but we have seen that the current models are not as 'right' as we predicted" was one of the main statements at the seminar 'Managing the climate-water-forest nexus for sustainable development – Are we on the right track?' held in Wageningen, The Netherlands on 12 November 2015. Three presenters and three panellists shared their knowledge and tried to explain why the climate-water-forest nexus is so important in terms of environmental conservation and well-being of the society. Which are the new findings around the interrelations of this three topics, which are the misconceptions of the current models, and what can be done in order to head towards a more sustainable development?

An audience of 115 participants learned that there are some misconceptions around the existing models and the current understanding of the linkage between climate, water and forests. Most of the times they are studied as independent systems, and many aspects have been overlooked when making recommendations for policies and management.

*The 115 participants of the ninth On The Right Track seminar consisted of policy makers, researchers, consultants and private sector professionals and students.*

> *"In terms of the climate agenda, forests come as a kind of land-use that stores an enormous amount of carbon but they do not come as a kind of land-use that plays an important role in water cycles" – René Boot on introducing the seminar.*

The re-evaluation of the role of forests and their interrelated systems was the centre of the discussion. As stated by the Chairman, the Director of Tropenbos International René Boot, during the introduction of the seminar, forests are more than just a 'storage' of carbon. In the current context of climate change, hydrological models of forests still have a lot of room for research. Terrestrial moisture recycling has not yet been included on the current models. Huub Savenije explained why moisture is often recycled from 'far-away' land than conveyed from the sea. And he pointed that hydrological systems should be considered scale independent. Douglas Sheil remarked on the importance of continuous forests and how avoiding deforestation can bring positive feedbacks to the hydrological system and moisture cycling. Sampurno Bruijnzeel presented that better understanding of soil degradation is critical to understand the role of forests in global moisture cycles. The local availability of water is not just dependent on tree cover but also on soil conditions.

During the panel discussion, the panellists highlighted that forests with stable hydrological cycles are not just important in terms of environmental benefits. Social benefits and the well-being of the communities and their livelihoods, either from a rural or an urban view, have to be considered as well. This is an important argument to involve the local communities in sustainable development initiatives. Furthermore, multidisciplinary scientific approaches that take the global to local interactions into account, are key when developing effective initiatives. Policies could best be initiated at national level while solutions should be address at local levels. The

"traditional" mismatch between science and policy makers should be overcome, and participation of private-sector, NGO's and smallholders should be encouraged.

*The seminar's 5 panellists, on the discussion about 'managing the water-climate-forest nexus'. From left to right: Jelle Behagel (WUR), Jullie van der Bliek (IWMI), Jan Willem de Besten (IUCN-NL), Douglas Sheil (NTNU) and Sampurno Bruijnzeel (KCL).*

*Are we on the right track?*

Science is already moving towards the re-understanding of forests and its interconnection with water systems and climate change. But this 'new nexus' concept still has to be included in the climate change and sustainability agendas. Science, policy makers, communities and businesses need to work closely together to have a better knowledge on the global and local impacts of forest land-use and its hydrological cycles, using more complete systems models.

## Background

The new set of 17 Sustainable Development Goals and associated targets adopted in September 2015 highlight the diversity, urgency, ambitions and interdependent nature of the challenges to eradicate hunger and poverty and to promote sustainable socio-economic development, while safeguarding our finite natural resources and ecosystems.

Climate, water cycles and forests are three essential and closely intertwined elements of our natural capital. If well-cared, forested landscapes can provide a stable and secure environment for agriculture, safe water supply, energy and healthy living conditions and livelihoods, amongst others.

The interactions and feedback loops between climate, water and forests are manifold and complex; and some are well understood, whereas others are much less so. In this annual seminar we took stock of the latest knowledge and insights on the interactions between climate change, water cycles and forested landscapes and what this means for research, management and policy. We did so particularly from a macro (e.g. global, regional) and meso (e.g. watershed) perspective.

Three reputable experts and three additional panellists addressed such diverse questions as: Wat are the effects of forest land use changes on rainfall patterns, temperature and atmospheric dynamics? What are the misconceptions of the hydrological systems of forests? How important are forests for the recycling of rainfall or as a 'biotic pump' bringing moisture from oceans to inland regions? Do the interactions between climate, water and forests receive the recognition they deserve? Are we on the right track in translating the latest scientific insights into robust public and private policy agendas, management practices and capacity building for forested landscapes?

## Objectives

The seminar aimed to give a better understanding on the linkage between climate, forests and water at different scales (global and local). And to provide input to national and international policy agendas, the current SDGs and management of forested landscapes. Expert speakers presented and overview of how the relation of these three systems has been understood so far and what are the new findings. Continuing with a panel discussion, where statements were presented on the situation around practice and policies, and what needs to be done in terms of sustainable development.

## Programme

*Session 1: Presentations*

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| How important are forests and land use to sustain global rainfall? | Huub Savenije |
| How forests water our planet: recent advances and current controversies | Douglas Sheil |
| Tropical forests, reforestation and water yield: Bringing in soil degradation for added realism | Sampurno Bruijnzeel |

*Session 2: Panel discussion*

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| René Boot (panel chair) | Director, Tropenbos International, Wageningen, The Netherlands |
| Jelle Behagel | Assistant Professor, Forest and Nature Conservation Policy Group, Wageningen University |
| Julie van der Bliek | Advisor, International Water Management Institute |
| Jan Willem de Besten | International Union for Conservation of Nature, The Netherlands |
| prof. dr.Douglas Sheil | Professor, Norwegian University of Life Sciences |
| Sampurno Bruijnzeel | Visiting Senior Research Fellow, King's College London, UK |

** prof. dr. Huub Savenije, Professor of Hydrology, Delft University of Technology was not able to be present in the panel discussion*

## Participation

The seminar was attended by 115 participants. About 70 were students, 30 came from different knowledge and research organizations, 10 came from the private sector, and 1 was from the Ministry of Economic Affairs, Nature & Biodiversity Department.

## Introduction


René Boot welcomed the participants and started by underlining the importance of the interrelation of climate, water cycles and forests on the natural capital and the ecosystem services they provide. He remarked that the interaction of these three elements is complex and not fully understood, and as a result it is often overlooked. Especially the interconnected impacts of land-use changes are not taken into account.

He made the observation that the focus of international policy sectors is too limited; climate: carbon footprint, water: sanitation, forests: timber or biodiversity. While the highly needed broader view is often lost.

*"Is that the wrong way of looking at it?, Are we on the wrong track?" ,* René asked and explained that this seminar was meant to help better understand the current state of knowledge on the linkage between climate, water and forests, and how that will help on providing better policies and sustainable practices.

## Highlights of the presentations[1]

### How important are forests and land use to sustain global rainfall?

*Huub Savenije*

What role do forests play in hydrology? Are forests important for sustainable hydrological cycles? Intuitively, we would like them to be, but is it 'scientifically' true? The role of forests, land use and hydrology and their interrelation needs to be reviewed. In the past, moisture recycling was studied locally, which made further research on hydrological cycle's very scale dependent. New approaches that are global and scale independent on moisture recycling are needed.

These were the first statements of Huub Savenije. He continued by briefly explaining the components of the global water cycle (precipitation, evaporation, and transpiration). Water which comes to land through precipitation can be cycled back through interception (direct) or transpiration (indirect through vegetation). He illustrated that globally, 40% of precipitation (rainfall) is of continental origin. For example, large parts of Asia, the Sahel and the area south of the Amazon rely on recycled moisture of terrestrial origin. Therefore, precipitation in China has to a great extent its origin in Western Europe as a result from recycled terrestrial moisture and not only from the ocean, as previously assumed.

He further explained, that different aspects of moisture recycling can be calculated such as the source, distance and time the moisture needs to travel. Data on moisture recycling from worldwide basin areas clearly indicated that moisture recycling does not obey national or river basin boundaries. For instance, the Volta basin in west Africa receives almost 60% of its moisture from terrestrial origin, but only about 10% of this moisture is sourced locally, thus 'internally recycled'. Research also reveals that even the size of basins does not appreciably change the contribution of moisture from terrestrial origin or moisture locally recycled within the basin.

At the end, Savenije emphasized that, if we change the land-use locally it might have a noticeable impact over a long distance (e.g. sustainable land-use in east Africa could have an effect on precipitation rates in the Sahel). Forests do regenerate precipitation and sustainable land-use can result in regional impacts elsewhere.

[1] All the PowerPoint Presentations can be downloaded from:

And forests are important for recycling water, both through interception and transpiration. But we do not know what the effect of replacing forests with crops would be. Therefore, he called attention for improving smallholder farming practices, as farms continue playing a role in regenerating precipitation.

*Afterwards, questions from the audience were raised. One concern was expressed about Brazil. Some areas face dramatic declines in water availability, but does this phenomena relate to changes in land use or does it already indicate effects from climate change?*

*Savenije explained that, in hydrological terms, land use changes are proven to affect run off and local hydrological cycling (especially when forest areas are cleared). Effects from climate change are not scientifically proven yet. Land use changes have an impact on local conditions but mostly somewhere far away due to the fact that terrestrial moisture travels long distances. But it also should kept in mind that droughts are a normal natural phenomenon.*

*Another concern was whether increasing temperatures (e.g. from climate change) could influence moisture recycling? He further explained that global warming is not just temperature dependent but mostly moisture dependent. In simple words: when it gets warmer, evaporation increases and therefore more moisture is released to the atmosphere.*

### How forests water our planet: recent advances and current controversies

*Douglas Sheil*


Recent droughts in the Amazon and elsewhere fuelled the debate on the role of forest cover changes and their effects on precipitation. New theories suggest that tree cover influences rainfall patterns to a greater extent than it was assumed in the past.

First of all, Douglas Sheil made clear, how important water for the people is. 'Reliable rain' is essential for maintaining livelihood models and strategies. Moreover, it is crucial with regard to food security, health, industry and environment.

In the past, observed rainfall patterns and their connection to forests weren't understood very well. Nowadays, findings have shown that forests evapotranspire large amounts of water and they are very efficient at it. In fact, closed tropical forests evaporate 1-2 meter/year even more efficient than water bodies (considering the fact that "leaves on a tree are hanging out like laundry to dry"). Likewise, forests contribute to aerosol density in the air which make it easier for water to condensate and thus help to form clouds.

Recent advances have shown that over the half of the evaporation from land returns to it, and most of it comes from vegetation (80-90%). Not just forests, but also trees on dryland contribute to water cycling mostly due to their ability to root in deep soil layers for reaching water.

There are large amounts of water flowing out of regions, but how does this water get back inland? Using the example of the Amazon, Sheil explained, that wind is a supporting force for moving water (moisture) back land inwards. The traditional explanation of air circulation ("thermal explanation") due to temperature differences (land=warm, water=cold) cannot always be applied. Basically, winds bring moist air to land whereby clouds are formed. However, in the Amazon the ocean water is often warmer than the land, which is known as the 'Amazon Paradox'.

Continuous forest cover is important for interior rains, because normally rainfall declines as it moves more to the interior of lands, except over forest areas. Some experts do not believe that forests attract rain (since it cannot be proven scientifically). However, Sheil mentioned two scientists from Russia who came up with a

theory. Instead of focusing on temperature, the two scientists focused on the density of particles and pressure. They claimed, that an area with high evaporation will develop a low pressure after condensation which attracts moisture and since forests have higher evaporation levels (higher than the ocean) the resulting low pressure might explain why moisture is attracted (which also explains the Amazon Paradox). This phenomenon can be observed in boreal forests, where this effect disappears during winter time (when evapotranspiration is reduced), and a period with low inland-water-movements. The theory can explain specific phenomena, but still it is considered by other experts to be very controversial.

Douglas Sheil concluded that, continuous forest cover maintains interior rainfall patterns and deforestation could "switch off" this positive feedback mechanism. He also pointed out some opportunities for future "greening desert" projects and gave some figures that come along with these findings.

### Tropical forests, reforestation and water yield: Bringing in soil degradation for added realism

*Sampurno Bruijnzeel*

At the very beginning, Sampurno Bruijnzeel made it clear that soil degradation plays an important role in many deforested tropical areas which affects local hydrological functions. In the ongoing debate on tropical forests and water, the linkage to soil degradation has never been a popular subject and comparatively little scientific work has been done so far on the hydrological impacts of soil degradation.

In response to widespread soil degradation and in the hope of restoring original conditions, large tracts of the tropics have been reforested in the past. Instead, the high water use of fast-growing tree plantations has caused major reductions in streamflow after foresting grass- or shrublands in warm-temperate and subtropical regions. This finding has dominated the debate ever since, to the point that the possible boosting of dry season streamflow by tree planting or re-greening activities is dismissed by most people.

First, Bruijnzeel briefly explained that during rain, runoff from the hillsides leads to temporarily increased streamflow, so called 'stormflow'. This 'stormflow' can assume disastrous proportions during extreme rainfall events and is usually a nuisance (causing flooding, silting up waterways) compared to the regular 'baseflow' that is used for irrigation and domestic purposes.

The "sponge" concept in the 'traditional' view of forest hydrological functioning implies that a well-developed forest absorbs all the rain and releases the water again slowly, thereby maintaining dry season baseflows. An intact litter layer and high soil faunal activity promote rapid and deep infiltration. However, experts are concerned about the "forest sponge" concept since trees also use a lot of water, also from deeper soil layers. This 'modern' view emphasizes the higher water use of trees and forests compared to shrub/grass or crops and stresses the experimental finding that annual streamflow totals increase with the degree of forest removal. Thus, in this view, forest clearing would enhance streamflows rather than decrease them as suggested by the traditionalists.

Deforestation may increase water availability throughout the year due to the lower water use of annual crops replacing the previous forest, but only if the soils remain well-managed. If not, the soil's absorption capacity becomes critically reduced and stormflows greatly increased. The water thus lost to infiltration into the soil no longer contributes to groundwater recharge, and springs and baseflows decline due to the loss of the 'sponge effect'.

Bruijnzeel further emphasized that soil degradation has rarely been taken into account in tropical catchment experiments which arguably renders their results less than representative for 'real-world' conditions. The local availability of water is not only dependent on vegetation cover but also on soil conditions. Thus, the net effect of planting trees on streamflow will depend on the balance between the resulting changes in both evaporation (tree water use) and infiltration (soil improvement). Focusing only on the evaporation aspect will lead to biased predictions as demonstrated by various examples given by Bruijnzeel.

Several conclusions may be drawn according to Bruijnzeel with respect to the impact of tropical reforestation on streamflow. A global modelling study suggests that areas with high rainfall and advanced soil degradation

might well benefit the most from reforestation but drier areas are likely to see a further reduction in baseflows. Further, agroforestry might be more acceptable socially and be more suitable hydrologically than large-scale plantation forestry but the hydrology of agroforests and regenerating (secondary) forests is not well understood or documented. It is therefore wise to conserve primary forests where possible.

*After the presentation, a participant of the seminar asked about the role of biodiversity in hydrology. Bruijnzeel explained that ecosystems with high biodiversity are generally more resilient (e.g. to external threats such as diseases, storms, fire, etc.) but forest water use does not differ much between (evergreen) tree species although peak water use is reached more quickly by faster-growing species. Infiltration of water does not strongly depend on the number of soil faunal species – one species of earthworm could do the job – but this would make the system more vulnerable.*

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## Panel discussion

*René Boot recapitulated that in the first session the speakers gave an overview of the scientific evidence on the linkage between climate, water and forests, and that the next session was to move on to the implications on policies and practice. He presented the three new panellists and asked them for their points of view on the current linkage between climate, water and forests.*

*Jelle Behagel* mentioned that the policy community has not much 'doubt' about the positive role that forests play, so the presentations raised new perspectives. He remarked that we mostly talk in terms of global maps but policy actions take place at a regional and local level. There is clearly a mismatch between science and policy makers. He would like to see more focus on the importance of forests for water from the perspective of urban areas. 'Green infrastructure' could be a good alternative for water availability and water quality in cities that are going through water crisis.

> *"A major driver for water crisis is increased urbanization and intensification of agriculture and what I did not hear is about the water needs that are also affecting people there"*
> Jelle raising awareness on watching the interlinkage of climate, water and forests from a 'city' perspective.

*Julie van der Bliek* mentioned the importance of good water and landscape management for food production. And as forests are part of that landscape, in a bigger picture, it is important to understand how the different land uses work on fulfilling different needs of people. She appreciated that the first two presentations draw attention to the large scale impacts and the importance of terrestrial moisture recycling circles. She highlighted that groundwater is also an important issue to explicitly put on the forest agenda, especially groundwater recharge. Upstream-downstream relationships are of utmost importance.

> *"Areas with continuous forest cover are extremely important but at the same time we know the reality that many human needs need to be met"*
> Julie stressed the importance of multifunctional landscapes that can provide both functions.

*Jan Willem* said that the last presentation in which was stated that planting trees can in some situations lead to less water got him thinking. He mentioned the importance of bringing expertise and inputs to the areas of need, and that more 'local maps' are needed. Three main challenges are to be met: feeding the world, water availability and production of energy; it is important to remember that soils, hydrology, biodiversity and forests are all interlinked. And that it is time to integrate science, government, business, NGOs and local people, to get knowledge transfer at different levels because solutions and models do not fit everywhere. Finally, he acknowledged the importance to take the interest of local people and farmers into account, because they have the capacity to learn, take decisions and bring expertise.

> *"We need to integrate various fields of expertise and leave the silos... We have to operate at different levels… We need the government to have the right rules and regulations… We need to start looking at people as equals…. and we should not look for one solution".*

*René continued with the discussion by recalling that the link between climate, water and forests is complex and asked to the experts if there are real consensus emerging in the subject and if there is enough knowledge to make useful recommendations about it.*

*Sampurno* remarked that there is still a lot to learn and that some theories are questionable, e.g. the biotic pump theory of rainfall generation which might be right but for the wrong reasons (e.g. biogenic aerosols serving as condensation nuclei vs. excessive moisture production by forests). He nevertheless suggested using the cautionary principle ('better safe than sorry') and to remember that it is important to always critically assess the outcomes of models, and to test them at the local scale using field measurement where possible. He believes that we would already gain a lot if the most vulnerable parts of tropical landscapes (headwater areas) would be under forest cover.

*Douglas* commented that we do know that the climate system is greatly dependent on living systems, and that many major uncertainties relate to this, he argued that biologists must get more involved in the cross-disciplinary research relating to climate and hydrology. His second point was that critical debates in science are key to science. Policy makers should not blame scientists for highlighting uncertainties and debates, as this is a widespread misunderstanding of what science is.

> *"We need to offer the best inferences we can with the information we have but it will always be provisional, and policy makers need to engage and work with that."*

*René recalled the raising awareness of the interaction between policy making and practice and asked the panellists to give their opinion on how they see the future of this topic, climate-water-forest nexus, in terms of policy making.*

*Jelle* - Regional policies are crucial, they result in immediate changes on the ground in a relative short period. Waiting for science can never be an excuse not to act. But it is also a challenge because sometimes poorly informed actions can lead to some negative consequences on the ground.

*Julie* - Referring to the current SDGs, the next step for scientists is to inform policy makers to look across those SDGs, taking into account the impacts on different targets, and the impacts at local level. Also looking for solutions which can address several targets simultaneously. Policy makers do need more applicable information, and scientists can help by developing scenarios or models that can be help them define their development pathways.

> *"Policies within the framework of the SDGs, need to addressed at the national level but the solutions should be at local levels."*

*Jan Willem* - When it comes to 'science in practice', on the ground (e.g. working in development cooperation with communities) we need to be very careful on what we say to the people, because it can create expectations on systems where climate variability can bring up different results than the ones predicted.

*Douglas* – Within the whole 'climate change' discussion local communities should be encouraged and motivated on the ground needs to engage with people and their interests and understandings. While carbon rarely considered, a clear motivator is access to useable water, and that means that it is a much better focus for gaining interest and building local collaborations.

*Sampurno* - It is important to be careful with what you claim and not to lose credibility (i.e. do not make sweeping statements but instead keep a regional focus). We have to stay conscious of the hydrological effects of different uses of the land and pay more attention to the role of soils instead of focusing entirely on vegetation cover.

> *"It is important not to overstate the advantages of our actions… You can't promise… You have to be realistic on what we can expect"*

## Questions and opinions from the floor

Q: *Freek Wiersum*, *WUR Nature Conservation Group*. He missed: What type of forest are we talking about? What kind of forest does provide the aforementioned improvements? Is it about tree planting in a mosaic landscape?

A: *Sampurno*: Theories and data shown were mostly related to primary forests; much less is known about secondary forest hydrology, and secondary forests need to be integrated in climate and hydrological models. Secondary forests often use much more water than primary forests which they need for creating biomass (growth). He further suggested that in future agro-forestry may become the dominant land use in the tropics because in contrast to tree plantations it provides the necessary goods (food, fibre, fuel) while adequately protecting the soil against erosion and using less water than a full tree cover.

*Douglas:* It is not just talking about forests and non-forests, but about appreciating the role of trees in landscapes. For example, there is a widespread perception that planting trees in arid regions will lower the water table as this is what is seen in densely wooded versus open areas. But recent CIFOR work in Burkina Faso shows that in fact adding trees at intermediate densities can, at least in that site, greatly improve infiltration and thus increase groundwater recharge. We need to see tree density as an important variable and challenge the misconceptions that arise with the "forest-no forest" viewpoint. .

*Jelle*: The main question is how to halt deforestation. It is strongly related to the intensity of agriculture and is strongly locally determined. He advises to look into the different trade-offs and maybe use rules of thumb.

Q: *Amanda Groenhof*, *student of tropical forestry at Van Hall Larenstein*. What should students do with this information? What is the advice for their future?

A: *Panel:* People who know about what to do with forests are always needed, especially in the fields of reforestation and agroforestry. Trees play a crucial role in the landscape, so forestry should be combine with other needs and processes. There is so much to be learned and a lot to be done.

*Wyb Jonkers*: Which are the qualifications policy makers need?

A: *Jan Willem:* It is true that sometimes policies do not work, but the real change is in the collaborative effort. Policy makers need more "on the ground" contact and get outside their own comfort zone. He would encourage a better communication with the scientific community.

*Douglas:* We cannot just tell people what to do and expect them to do it. Those days are gone. It is important to find why people should care about something and persuade them. We want the world to be more democratic and we welcome democracy so we have to deal with the consequences of that and make sure people are well informed and can judge which policies are required.

*Julie:* "Sometimes 'we' (scientists) have the wrong attitude to approach policy makers. The scientists should be able to convince them!" Sometimes it is important to find right angle to make policy makers interested and convince them that the information is relevant enough to act.

## 'Take Home' messages

*Jelle:* Water, climate, and forest are interconnected, but "we need to tell this story in new ways that highlight these connections". Together we have to find solutions.

*Julie*: It is important to keep the discussion at the different levels and scales, to recognize all the sectors involved and to understand their roles. Cross-sectoral approaches are needed.

*Jan Willem*: Remember the foundation of landscape, biodiversity and ecosystem. "Solutions should be home grown". Important to look at the value chain both horizontally and vertically, how to bring it down global thinking to local solutions.

*Douglas:* I'd highlight the risks and the unknowns. The link between forests, water and climate is clearly important but we need to underline that we don't know enough. There are huge risks in not knowing the vulnerability of these systems and dependencies. We need people to know this. It is not a detail. We should be worried. There are big uncertainties and big dangers. And young scientists should help find the global links and the local solutions that can deliver a healthy environment.

*Sampurno:* More and better transfer of scientific knowledge to the local users is needed. The current generation of scientists relies mostly on model predictions and is less out in the field validating and interacting with the local people. Much is possible: *"Be realistic, plan for a miracle".*

## Final reflection

Continuous forest cover is important for interior rains and deforestation could lead to adverse effects on interior rainfall patterns but also to disturbed or extreme hydrological effects, especially when forests are cut and soils become degraded with poor infiltration characteristics. However, one thing is certain, local livelihoods rely on stable rainfall conditions to maintain their well-being or to gain positive livelihood outcomes.

The seminar also pointed out the importance of soils. Local availability of water is not just dependent on tree or forest cover but also on soil conditions, and unfortunately the scientific community has given little attention to it. Hydrological characteristics of agroforestry systems, which are able to deliver environmental, economical, and social benefits to local communities, are barely documented or monitored.

The complexity of the climate-forest-water nexus will require cross-sectoral approaches and especially local solutions that involve local people to ensure sustainable development. Science came up with several theories, mostly screening the global view on forests, water and climate. But in reality, policy actions take place on local or national level with immediate effects and changes for the people "on the ground", in a relative short period of time.

It was understood that the "traditional" mismatch between science and policy makers should be overcome, by finding integrative ways of transferring knowledge not only between policy makers and science, but also between private-sector businesses, NGO's and smallholders. The idea of 'global solutions' fades more and more. Local realities need to be recognized and complex interconnections of climate, water and forests need to be elaborated in tailored approaches on landscape level.

Even in climate change mitigation projects (e.g. REDD+), the role of water and its connection with forest cover should be considered much more. Next to carbon, which has something 'abstract' when it comes to

implementation phases within local communities, water is a 'tangible' issue with probably visible effects on local levels and within project boundaries of development cooperation.

## Informal feedback and discussions

Students and other participants were asked for their thoughts, impressions and feedback, following some of the responses that were received.

*"The overall topic of this years' event was clear compared to the previous OTRT event (on landscapes)"*

*"Some presentations were, at some points, difficult to follow; conclusions were easy to understand"*

*"The panel discussion was little short"*

*"Personally, it was also inspiring; water is "the" crucial factor to meet future challenges in food security, biodiversity, energy, etc."*

*"I wish universities would organize this kind of events more frequently at their own facilities"*

*"For us students, it is an ideal place for networking, and discussions in an relaxed atmosphere (the 'experts' are easy to approach on this event)"*

*"Also, a lot supplementing material (books, brochures, flyers, notes) was provided"*

*"Sufficient information about the participants and their biodata"*

*"I will definitely visit the next year event"*

## Selected Resources


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