# Nexus Approach and Sustainability: Opportunities and Challenges

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## Abstract

Global problems have become increasingly complex and interwoven, across disciplines, geographic regions and sectors. Traditional compartmentalized approaches to knowledge generation by dissecting a problem to smaller components that can be managed by different disciplines do not work well in this context. It is necessary to find ways to address problems in an inter-disciplinary manner that promotes taking a holistic viewpoint. While the traditional discipline based knowledge generation has been very effective in advancing knowledge and technology, we need new platforms to put the pieces back together to solve these interwoven complex problems. Nexus approach is such a platform where one can address interlinked problems in an efficient and effective manner. The solutions we seek need to be targeted towards development that is equitable and sustainable. Hence it is important to link the approaches, solutions and linkages within a Nexus platform with global development agenda and concrete actions required to achieve them. This paper describes the approaches to sustainability, sustainable development, global development agenda and how they may link with a particular nexus platform. Importance of capacity development customized to local conditions to achieve these global targets cannot be overstated, and challenges and opportunities in integrated approach to research and education is discussed with experiences from the postgraduate programme of UNU-ISP.

## Environment and the Earth System

Global environmental concerns grew since late 1960's with the realization of the difficulties associated in trying to meet needs of rapidly growing population with ever increasing demands from earth's limited resources. The space travel made it possible to view earth from outside that highlighted 'spaceship earth' as a total living system with interconnected environmental processes and finite resources. The UN Earth Summit in Stockholm in 1972 was instrumental in channeling these concerns towards a global movement that that demanded attention to effects of human development on nature. The UN report on development issued by World Commission on Environment and Development report, Our Common Future (1987) also known as "Brundtland Report," provided a common platform for different stakeholders and sectors to discuss ways to address this common goal within each discipline. Its definition of sustainable development as the "development, which meets the needs of the present without compromising the ability of future generations to meet their own needs" has linked the carrying capacity of earth environment across generations. While the definition of sustainable development does not provide a precise mechanism for quantifying sustainability, the flexibility it provided allowed different disciplines to explore its meaning and to communicate across disciplines (Dally, 1990). The report was followed by the United Nations Conference on Environment and Development (UNCED) in 1992 in Rio de Janeiro that produced a detailed action agenda, the agenda 21, and UN conventions on Climate Change and Bio Diversity. In 2002 the World Summit on Sustainable Development held in Johannesburg, South Africa reiterated the commitment to address the relationship between the human society and natural environment. The summit came up with an agenda of five priorities, water and sanitation, biodiversity and ecosystems management, energy, agricultural productivity,

and health for promoting both development and sustainability (Annan, 2002). These conferences and activities in-between them has greatly facilitated in generating global interest and follow up on the human development activities and their linkages and dependence to earth environment.

## Addressing Sustainability

The recent manifestations of adverse impacts of global environmental change such as climate change, biodiversity loss, global water scarcity has renewed global interest on the need to address sustainability systematically. The discussions within each discipline have been converging towards inter-disciplinary approaches on the basis of 'sustainable development' objectives. For example, as a discipline, economics is usually concerned with allocation of limited resources across all needs in an efficient manner. The primary focus of economics as a discipline on sustainability is the trade off of current consumption for future consumption (Elliot, 2005). However, the traditional measure of success of economy as the growth of GDP in a given time does not address the issue of resource depletion or use of non-renewables in generating this wealth. The capital used to produce goods needs to be viewed from sustainability viewpoint to clarify the relation between nature and human needs. The total stock of capital may be considered as the sum of natural capital (Kn), i.e, the resources that come from nature, the human capital (Kh), i.e. the knowledge and technology people bring to the production and the capital created (Kc) such as infrastructure and machines. According to Elliot (2005) a group of economists argue for a weaker form of sustainability, where, as long as the total capital remains unchanged the current generation can use a larger share of Kn and leave future generation with increased Kc (better and efficient machines and technology) and Kh (improved knowledge).

On the other hand there is an opposing group of economists who do not consider that these different forms of capitals as substitutes. This second group belongs to the discipline 'Ecological Economics' that has been established more than 20 years ago to discuss the relationship between economics and ecosystems. They subscribe to a 'strong sustainability' view that requires maintaining both man made and natural capital intact separately (Dally, 1990). This approach requires addressing the issue of non-renewables essential to maintain human economic and development activities today. Dally (1990) suggested a way of overcoming this difficulty by proposing to invest in renewable substitutes for non-renewables, so that when the non renewable resources are depleted there will be renewable substitutes to take their place. In a recent article in BioScience, Raudsepp-Hearne and colleagues (2010) challenged this notion that ecological damage will eventually lead to decline in human well being by pointing out, in spite of the declining ecosystems services as identified by Millennium Ecosystems Assessment (MA, 2005), the human well-being has been steadily increasing as captured by the continuous increase in human development index (HDI). However, the sustainability approach should not be viewed from a reductive stock-flow framework where natural capital is only producing eco-system services, but holistically considering the complexity, irreversibility, uncertainty and ethical predicaments intrinsic to the natural environment and its connections to humanity (Ang and van Passel, 2012).

According to Baumgärtner and Quaas (2010), ethical considerations of sustainability economics need to go beyond the economics-environment relation and aim at justice (a) between human generations (b) within a human generation and (c) between nature and humans. The objectives of economics and social sciences go beyond the domain of justice between humans and nature. It targets the aspiration of every human to address the needs and wants in an equitable manner. Based on the above they argue that sustainability economics should be based on efficiency of resource allocation to achieve two normative goals of (i) achieving needs and wants of individual humans and (ii) promoting justice as given from (a) to (c) above. The aspect of justice towards nature in (c) is important not only as a justice towards intrinsic value of nature and consideration for other species who share the earth with humans, but also for the importance of preserving the

interconnectedness among earth system processes needed for the regeneration of renewable resources and ecosystems services that are essential for the survival and well being of humans.

From environmental viewpoint, natural resources base also has ecological functions that keep the earth system as a living organism. This implies maintenance of cyclicity or equilibrium status of major biogeochemical cycles such as carbon cycle, nitrogen cycle and water cycle as well as energy balance of the earth system. Disruptions to these cycles or balances may lead to environmental conditions that are significantly different from the present environment in which the current society has developed. Such manifestations can be seen at small scale as increases of flood frequencies and temperatures in dense urban areas due to changes to water cycle and energy balance, or in large scale as climate change due to disruption to earth energy balance.

A sustainable ecology requires that our needs for environmental services can be met without damaging the sustaining natural system. This also requires consideration of environment to absorb waste. Ecological security is defined as the status reflecting the threat to human living, health, basic rights, guarantee of secure life, necessary resources, social order and the ability to adapt to environmental change. This covers environment, economy and society and relates to environment and human security concept. The definition also is close to the ecological economists description of sustainability discussed earlier. The major achievement of sustainable development concept is to bring close natural and social sciences (Dally, 1990) and its ability to serve as a grand compromise between those who are principally concerned with nature and environment, those who value economic development and those who are dedicated to improving the human condition (Kates et al., 2005).

## Development Targets: MDGs and SDGs

While there is general agreement of the three pillars of sustainability there is no general agreement on the subdivisions of each of these dimensions. Indeed one may argue that these divisions are not static but are dynamic, varying with time and societal needs. Thus, another approach to identify what sustainable development aims to achieve is to discuss its objectives in concrete measures. In September 2000, building upon a decade of major United Nations conferences and summits, world leaders came together at United Nations Headquarters in New York to adopt the United Nations Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty and setting out a series of time-bound targets that have become known as the Millennium Development Goals. Eight of the major goals targeted to be achieved by 2015 are monitored by different UN agencies. The 2013 MDG report by UNDP recognizes that MDGs are the most successful anti-poverty global initiative, as they succeeded in advancing global recognition of poverty and establishing partnerships for its reduction. However, more action is needed in hunger, maternal health, sanitation and environmental protection. A major limitation of MDGs was that it is carried out in a donor driven fashion without focusing on local capacity development for its sustenance. MDGs focuses on ends rather than means and the simple form of goals facilitated achieving basic needs of the most marginalized of the world. Beyond 2015, there is a need to redefine global development targets that encompass human aspirations and earth system sustainability.

One of the major outcomes of the Rio+20 Conference was the agreement by member States to launch a process to develop a set of Sustainable Development Goals (SDGs), which will build upon the Millennium Development Goals and converge with the post 2015 development agenda. The UN was asked to setup an inclusive and transparent intergovernmental process open to all stakeholders, with a view to developing global sustainable development goals to be agreed by the General Assembly (source: http://sustainabledevelopment.un.org).

Currently 7 work streams are engaged in the development of SDGs, which is expected to produce an interim report in 2014 and the final report in 2015. The working streams are the

- Open working group which is a 30 member government representatives
- High level panel of eminent persons chaired by presidents of Indonesia, Liberia and the British prime minister.
- UN System Task Team (UNSTT) co-chaired by UNDESA and UNDP and produced the report, the future we want.
- National, global and thematic consultations
- Regional consultations
- Sustainable Development Solutions Network led by Jeffrey Sachs with memberships from universities, research institutions, civil organizations, etc.
- UN Global Compact

According to the UN system task team (UNSTT) document the following three principles (a) respect for human rights (b) equality and (c) sustainability are proposed as the three principles on which the Sustainable Development Goals are to be built.

Unlike the MDGs, SDGs are expected to encompass not only the basic needs but also the human aspirations considering the sustained planetary wellbeing. Thus, the SDGs will have an *Ecological Ceiling* based on the criteria for planetary well-being and a *Social Floor* considering the basic human well being. The ecological ceiling will address topics such as biodiversity, chemical pollution, climate change, desertification, fresh water, land-use change, oceans, soil degradation, sustainable human development and waste management. It is interesting to note that water-soil-waste nexus is contained in the topics for SDGs currently under discussion. The social floor will be considering topics such as education, energy, food, gender, equality, health, jobs, poverty, resilience, social equity, voice and water. The implementation aspects of SDGs are also expected to differ from MDGs. While the global goals will be a normative framework that is aspirational, universal, time bound and will have means to measure, the implementation of this normative frameworks will depend on specific national targets compatible with own development goals and capacity building activities.

## Sustainability Science

What type of education is needed to achieve these development objectives? The traditional form of knowledge production has been organized in academic disciplines where the interest is primarily to produce knowledge on the interaction of physical and human components of nature. For this purpose universities have been organized in faculties and departments. The reward system, career system and quality control by peer review are contained within the disciplinary boundaries. On the other hand, as modern society increasingly demands application-oriented knowledge and the usability of scientific knowledge, integration of knowledge from various disciplines is becoming of vital significance. The 2001 World Congress "Challenges of a Changing Earth 2001" in Amsterdam organized by the International Council for Science (ICSU), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP) and the World Climate Research Programme (WCRP) proclaimed the birth of a new academic field, namely sustainability science, with strong roots in the environmental aspects of the sustainability concept (Kates et al., 2001).

Sustainability science has been proposed as a new discipline to integrate approaches and knowledge from different disciplines to solve interconnected global problems. Sustainability science differs from normal science in that it seeks a complimentary truth to traditional form of knowledge generation. Its objective is to ensure the sustainability of earth system. This means we need to have not only the knowledge related to earth system and its processes but also the competency to assess the consequences of knowledge application on the sustainability of earth system. Search of sustainable solutions to global problems requires new methodologies that bring together the three pillars of sustainability; environment, society and economy. Amongst others such an approach requires involving all stakeholders right from the start in developing projects and case studies, building on existing (local) knowledge and technologies and linking research, capacity development and implementation as briefly outlined below. Sustainability calls for integration and is well served by the nexus approach. Conversely, we may set up the objectives of nexus approach as to support earth system sustainability and address and resolve opportunities and conflicts in implementing nexus approach on the basis of sustainability principles.

## Sustainable Nexus Approaches

Fig. 1a Sustainability

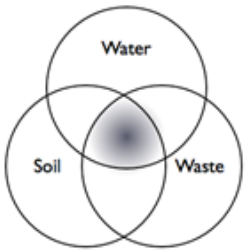


Fig. 1b Water-Soil-Waste

Nexus approach is a platform that brings together related disciplines and sectors based on the recognition of the importance of the interconnectedness of resources and their sustainable use. A number of important initiatives emerged recently to advance nexus approach in the context of resource management, notably in the water and energy, and water-energy-food, dimensions. A summary of the evolution of the nexus concept and its linkages to the UNU-FLORES initiative on soil, water, waste is discussed in Chapter 4 section 2 of this document. An effective and common approach to identify inter-dependencies and areas for improvement of resource use among nexus focus areas has been the full life cycle analysis of products and activities among the sectors in a nexus group. In addition to potential benefits, such analysis would also invariably identify conflict situations among them, especially in resource scarce situations. Resolving conflicts as well as optimizing resource use among different disciplines then calls for a framework for assessing effectiveness and evaluating trade-offs on common as well as independent activities and resource uses among the nexus focus areas.

In carrying out such analysis and addressing trade-offs among sectors, we should also make attempts not to confine nexus approach only to improve efficiency of resource use among the nexus sectors, but also take a broader viewpoint on the impact of resource use on the overall environment and societal well being. The figure (1a) shows the aim of sustainability approaches. We may consider that each of the circles represent a set of feasible solution in a given dimension to a particular problem. The objective is then to search for solutions depicted in the gray middle area that are acceptable environmentally, economically and socially. A similar approach can be adopted in the search for solutions agreeable to water, soil and waste domains as shown in (1b).

However, unlike the sustainability approach where a particular problem is viewed from different perspectives, there could be occasions in a nexus setting where it is difficult to find solutions that are easily resolvable, such as, waste management and water scarcity, or soil salinity intrusion and ground water use. In such cases it become necessary to look for solutions consistent with a higher dimension than the dimension where the conflicts arise. Sustainability provides a framework to address such concerns, where the acceptance of activities being considered in a nexus grouping can be assessed from all three sustainability dimensions. This mapping could be either one to one, or one to many as shown in the figure (2). It would be possible to seek a sustainable solution from environmental, societal and economic perspectives by addressing each from different nexus elements of an activity a community is engaged in as in the relation A of figure (2).

The activity could be one that engages all three elements of soil, water, waste nexus such as use of partially treated urban waste water in plantations to complete waste treatment and promote growth of trees. The economic benefit may come from the waster treatment component, the environmental benefits from $CO_2$ sequestration, water recharge, and social acceptance from greenery and amenity. The figure 2 A, is for illustrative purposes only and the linkages could be from any element of the nexus to any dimension of sustainability. If the project under consideration is large and complex, and has the potential to be split back to different compartments in the future it may be worthwhile to see that each nexus elemental component is sustainable on its own as shown by relation B of the figure (2), when trade-offs are considered. Chapter 4 identifies specific topics that may be undertaken under the soil, water and waste nexus that may be analyzed in this framework. The main objective of a sustainability framework would be to prioritize among a number of feasible projects working towards the production of similar goods or services.

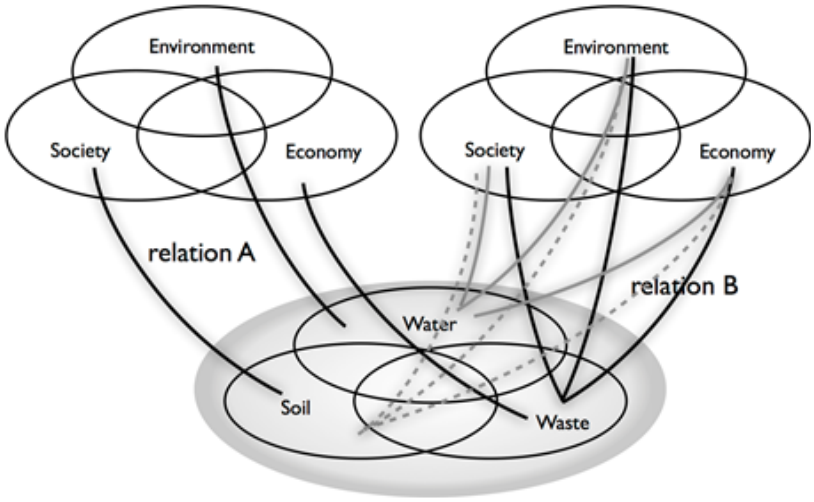



Fig. 2 Mapping water-soil-waste nexus with sustainability approach

## Research to Implementation and Capacity Development Needs

To support the societal demand for application-oriented knowledge, a new mode of application-oriented research is emerging on top of traditional academic research employing a wider set of organizations and types of researchers working in specific contexts on specific problems. Research is not exclusively based in universities but profit from the participation of implementation agencies, user communities and professional bodies. This development is especially useful for the developing countries where the major challenges lie in the difficulty of translating research to practice. This difficulty stems from lack of investment for research in industry and business (Schaaper, 2011), which in the developed countries plays the vital role of converting research, conducted in universities and specialized research institutions to practice . Therefore, bringing research and practitioner communities together in developing countries to form partnerships for conducting and implementing research is extremely important to advance locally relevant sustainable development practices adopting advances in science and technology.

Another major challenge faced by the global community today is the difficulty in adjusting to rapid rate of global changes and the uncertainty of the future status of environment they bring about. Developing countries face these burdens more as they try to overcome the challenges of meeting growing resource needs and managing environment changes, including climate change impacts.

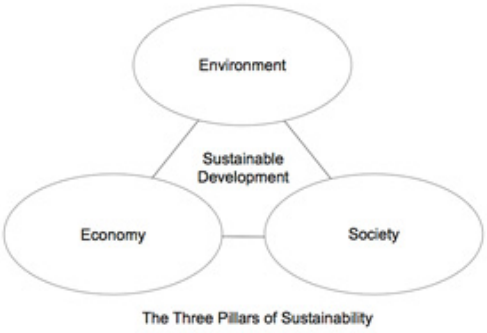
To be sustainable, societies need to adapt to global changes according to local conditions. For example, it is well known that although climate projections provides us with general trends of change, the information required at local scale for designing adaptation measures is not easily available due to various associated uncertainties. Not only the future climate conditions would vary with the selection of future forcing parameters, even for a given future scenario different climate models provide a widely varying range of future projections. In addition, methodologies adopted in downscaling from global to local scale as well as correcting the projected data to match with past observations by bias correction approaches introduce further uncertainties to projections. Thus, adaptation has to be a continuous process aided by improved observations and projections at the local scale. Therefore, to be sustainable under global changes, societies need to be adaptive and measures for adaptation have to evolve and be managed locally. From the above, capacity development at both national and subnational levels to assess impacts of global change and design adaptation strategies emerge as one of the most important requirements for sustainability (see chapter 3).

## Nexus Approach: Challenges and Opportunities

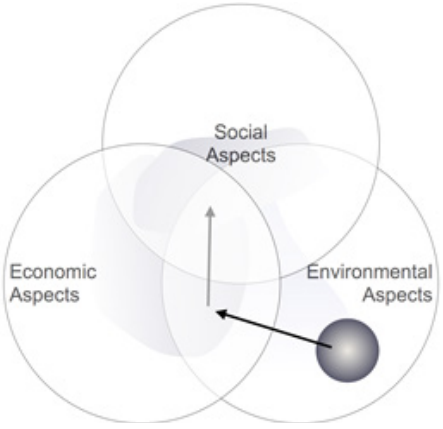
### *Integration across disciplines: Research*

As described above the need to integrate across disciplines is accepted broadly as a requisite for sustainability. The increase of efficiency and search for synergies is expected in the new programmes to be undertaken at UNU-FLORES in addressing Water-Soil-Waste nexus. In operationalizing such concepts it will become necessary to adopt research methodology models that will ensure this integration.

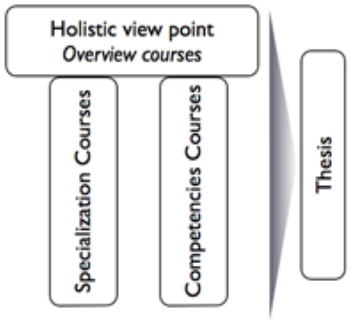
The Institute for Sustainability and Peace of the United Nations University (UNU-ISP) was established in 2009 to address the pressing global problems from a Sustainability Science perspective, taking a holistic view of the problems that cut across individual disciplines. In implementing the programme, UNU-ISP encourages research that seeks solutions based on different models that link environment, society and economy. One such approach is shown in figure (3b). Here at first a set of feasible solutions for a given problem, such as urban flood reduction with different types of structural and distributed measures, is obtained through environmental analyses. Then a subset of those solutions is identified which also satisfy economic constraints and finally solutions that pass the test of social acceptance should be selected for implementation. The analysis of each dimension would provide policymakers, scientists and community representatives to negotiate constraints and benefits in making a science based selection. A case study on this approach is presented in Herath et al. (2012b). A similar approach can also be taken in the water-soil-waste nexus, where the models for acceptance could be efficiency, minimizing resource utilization, etc.




(a) Sustainability Focus




(b) Research Methodology




(c) Educational Programme Components

Fig. 3 Research and Education in addressing sustainability

### *Integration across disciplines: Education*

Similar to research across disciplines, developing educational programmes across disciplines is a challenging task. Providing a broader understanding across disciplines is desirable, but will produce graduates who understand issues, but not experts to carry out research and programme implementation. To make a balance between broad overview education and the specialization required, the UNU-ISP M.Sc. programme consists of three components that provide;

- A broad holistic view point, through overview courses
- A deep understanding of a particular field through specialized courses
- A set of courses to provide skills needed to implement research, through competency courses
- The outline of the programme is shown in the figure (3c). Application to the water-soil-waste nexus is discussed in chapter 3.

### *Integrating capacity development, education and research*

In order to be effective, capacity development should target a range of stakeholders and actors who are involved in development processes and whose cooperative actions are essential for the sustainability of the development efforts. To be effective UNU-ISP, capacity development programmes cover the following three major target groups;

- Researchers and Postgraduate sector: This sector is the most important segment of a country that has the capacity and the resources to absorb new knowledge and customize it to local conditions. Educational programmes should endeavor to strengthen and engage the research/postgraduate sector in contemporary problems.
- Professionals/Practitioners: Professionals and practitioners need to be introduced to new methodologies and tools as well as emerging and modified design standards. In order to be effective, it is necessary to design programmes that can be conducted in a short time and can reach a wide audience.
- Administrative / Local governments: The final target group is the administrators and decision makers including local government officials, who need to have an over view of

the technology and science as well as its use. Key messages should be developed for this target group.

It is important to ensure that the above target groups do not work in isolation. This is a major challenge, especially for developing countries as discussed above. Capacity development programmes can be designed to address this issue by enabling collaboration among stake holders by conducting group oriented training where groups consist of participants from each stakeholder group who would continue to work together after the training programmes providing the long term commitment required for sustainable solutions. One of the approaches adopted at UNU-ISP is to develop pilot demonstration projects, which also act as field stations that promote such collaboration among the postgraduate, government and policy-making communities through applied research work. These demonstration projects provide the venue to customize knowledge and methodologies from the global scale to local scale. This concept is demonstrated in figure (4). To be effective such programmes should be tightly coupled with capacity development programmes and should run at least for 3-4 years. A case study of this approach with 8 demonstration projects conducted in four countries is listed detailed in Herath and Kawasaki (2012a).


Fig. 4 Integrated capacity development framework

## Regional Integration

Resource sharing through various networks and institutional arrangements can make a great impact and difference in the effectiveness of efforts to integrate knowledge across disciplines. It is encouraged that UNU-FLORES develop networks of researchers engaged in soil-water-waste disciplines. UNU-ISP has benefitted greatly in establishing a University Network for Climate and Ecosystems Change Adaptation Research (UN-CECAR). Research and education are the main focus of the UN-CECAR and the network brings together available resources and expertise across disciplinary lines to work collaboratively to enhance understanding on climate change impacts and advance adaptation research for the design of appropriate policy and development strategies. A sample of activities is shown in Figure 5. This approach not only helps to share expertise across educational institutions, but also helps develop research teams and researcher networks of both students and faculty to engage on sustainability issues.

## Conclusions

Rapid global changes and growing population demands bring unprecedented challenges in meeting the resource needs challenges of present and future generations within the carrying capacity of earth so that not only the present generation but also the future generations can meet their needs. The solution to these problems converges in integration of disciplines at different levels under the broad umbrella of sustainability. Integration of different disciplines and methodologies brings in new challenges as well as opportunities. New educational and research programmes based on sustainability science, where integration of different disciplinary approaches provides pragmatic solutions need to be developed and promoted. In adapting to rapidly changing environmental and social context of these problems, it is necessary to recognize localism, that is incorporating local characteristics in the solutions, is vital to make them sustainable. Postgraduate sector can be the ideal platform for disciplinary integration for sustainability and rapid dissemination and customization of useful global knowledge to local conditions, especially in the developing countries.


Fig. 5 Activities of University Network for Climate and Ecosystems Change Adaptation Research

## References

Annan, Kofi A (2002) Towards a sustainable future, Environment 44, 7, 10-15

Ang, F. and S. van Passel (2012) Beyond the Environmentalist's Paradox and the Debate on Weak versus Strong Sustainability, BioScience, Vol. 62, 3, 251-257

Baumgärtner, Stefan, M. Quaas (2010) What is sustainability economics? Ecological Economic, 69. 445-450

Dally, Herman E. (1990) Sustainable Development: From concept and theory to operational principles, Population and Development Review, 16, 25- 45

Elliott, Steven R. (2005) Sustainability: an economic perspective, Resources, Conservation and Recycling, 44, 263–277