Land-Water Linkages in Rural Watersheds Electronic Workshop

18 September – 27 October 2000

Introductory Note

Land-water linkages in rural watersheds: Introductory note for the FAO e-workshop

The purpose of this **introductory note** is to provide a "road map" for the workshop participants. It presents briefly the scope, purpose and focus of the workshop. The note is structured along the lines of the main discussion questions. For each question, it provides a short overview, and summarises key statements relating to the issue from the discussion and background papers.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, Italy

Introduction - Purpose and Focus of the Workshop

The electronic workshop **Land-Water Linkages in Rural Watersheds** is part of an interdisciplinary FAO effort to integrate the management of land and water resources on a watershed scale. Its main purpose is twofold:

(i) to review the linkages, or interrelationships, between land use and water resources, and

(ii) to exchange knowledge and information on mechanisms and instruments to link land and water management on the watershed level.[1]

For the purpose of the workshop, land use is understood as the combinations of activities in which substantive parts of the landscape are put into productive use, usually by a large number of people. This definition implies a large aerial extension – thus "rural watersheds" – and relates mainly to agricultural activities in a broad sense: agriculture, forestry, grazing and livestock production. The workshop will focus on the interaction between land and water resources. The issues of water allocation within river basins and of integrated water management which deal only marginally with land resources are not considered in this workshop.

The workshop will primarily focus on rural watersheds of small to medium size scale (from a few ha to a few hundred km^2). It may be subject to debate during the workshop if and how land-water linkages in larger river basins should also be discussed.

The workshop will address the linkages between land use and water resources from two perspectives, in order to facilitate the discussion:

First, from the ***Landscape Perspective*** – to discuss the nature and importance of biophysical impacts of land use practices on water resources in rural watersheds;

Second, from the ***Lifescape Perspective*** – to discuss the benefits and costs resulting from land use impacts to downstream water users, and instruments and mechanisms to distribute them between upstream and downstream populations.

The workshop will be structured in three parts and five sessions. Parts I and II will deal with land-water linkages from a landscape and lifescape perspective, respectively, and will be divided in two sessions each. In part III, conclusions and recommendations from the debate in the electronic forum will be formulated and discussed.

A series of discussion and background papers have been prepared to serve as a basis during the workshop discussions. The two **discussion papers** present the results of a literature

[1] There are different usages of the term "watershed" in American English and British English. For the purpose of this paper, "watershed" denotes the area in which all watercourses drain into a common point, be it a river or a lake. Alternatively, "catchment" may be used in the same sense. The line separating watersheds is referred to as a divide.

survey on land-water linkages which was conducted at FAO in preparation for this workshop. The five **background papers** provide a more detailed overview and insight into different aspects of land-water interaction. In addition, 28 **case studies** have been submitted which describe concrete experiences with watershed-based land and water management. These documents can be downloaded from the workshop website (www.fao.org/ag/agl/watershed). Participants are welcome to use them as reference and draw on them during the discussion in the forum. For easy reference, all papers have been numbered.

The purpose of this **introductory note** is to provide a "road map" for the workshop participants. It presents briefly the scope, purpose and focus of the workshop. The note is structured along the lines of the main discussion questions. For each question, it provides a short overview, and summarises key statements relating to the issue from the discussion and background papers. Thus, the note functions as a detailed workshop programme. Of course, this is open to additions and amendments. Participants are invited to propose their own questions to complement the proposed list. Amendments, however, need to be within the general focus and scope of the discussion theme.

Part I: Land-Water Linkages – the Landscape Perspective

Land use practices are assumed to have important impacts on both the availability and quality of water resources in rural watersheds. These impacts may be either positive or negative. To what extent different land use systems and practices affect hydrological regime and water quality, at which scales and in which socio-economic contexts the impacts are of importance, are questions which are still subject to controversy. This workshop will focus on those impacts which are felt by downstream users in a watershed context. For example, with regard to soil and water conservation practices, the discussion will focus more on how these practices affect the hydrology in the watershed and the impact of the changed runoff characteristics on downstream water users, rather than on the on-site impacts.

This first part of the workshop will focus on the biophysical interrelationships between land use and water resources in rural watersheds, i.e. watersheds with predominantly agricultural land use patterns. In the first session, the central theme is understanding and categorising the impacts of land use on water resources. Preliminary findings indicate that many of these relationships are not very clear, and that some of them may even be contrary to long-standing beliefs. The second session will focus on the assessment and perception of land-water linkages in a watershed context.

Session 1: Understanding and categorising land-water linkages

1. How can we classify biophysical land-water linkages in terms of land use impacts on availability and quality of water resources?

In order to discuss the impacts of land use on water resources, the workshop participants will have to agree on a typology. *Discussion paper 1* proposes a classification of impacts according to quantitative and qualitative aspects. It is proposed that impacts on water quantity be differentiated in those on overall water availability, or mean runoff, and those on seasonal availability, especially with regard to periods of extremely high and low flows (flood events and dry seasons). Impacts on water quality can probably be best classified according to the polluting agent (e.g. sediment, nutrients, pesticides). Is this categorisation sufficient to describe land-water linkages exhaustively? As pointed out in *background paper 2*, there are interrelationships between quality and quantity impacts.

2. What are the impacts of land use practices in rural watersheds?

Land and water interactions differ substantially depending upon the type of land use. *Discussion paper 1* gives an overview of impacts according to the proposed typology. *Background paper 1* discusses the impacts of forests, focusing on mean and seasonal runoff, sedimentation, and water quality. While there is a lot of literature on forestry, other land use forms, such as grazing, do not seem to have received much attention with regard to downstream effects. Can the workshop forum fill these gaps? Case study 28, for example, mentions the important role of rural roads in sediment production in tropical areas. Can we identify key parameters such as plant cover, evapotranspiration, soil infiltration capacity, or use of agrochemicals, which determine land use impacts on water resources? Wetlands have

been ascribed an important role with regard to regulating water availability and quality. What are the impacts of land use in such areas?

3. How do the impacts of land use vary in relation to agro-ecological and socio-economic conditions?

The actual impact of a land use will depend very much on physical and socio-economic conditions. What are the most critical interactions in different climate zones or agro-ecological environments? Which impacts can be observed across regions and climate zones, and which are of a more localised nature? What role does the socio-economic environment play with regard to land use impacts on water resources? How much do land-water interactions vary, for example, in relation to agricultural practices? With regard to forestry, *background paper 1* states that the management practices play a much bigger role in determining the impact on water resources than the presence or absence of trees in itself. Does this assertion hold true for other types of land use as well?

4. What are the relations between land use and living aquatic resources and ecosystems?

Whereas the present background and discussion papers deal mostly with physical impacts of land use on water resources, pertaining to change in availability or quality, land use can also have effects on living aquatic resources and ecosystems, with implications for downstream users as fisheries and aquaculture, or for the self-cleaning capacity of waterbodies. What impacts on living aquatic resources have been observed as a consequence of changing land use practices in rural watersheds? How can we include these impacts in our typology of land-water linkages?

5. What is the relative importance of anthropogenic and natural causes in degradation of water resources?

The relative importance of land use on water quality and availability may vary greatly in relation with many factors like climate, geologic formation, and the percentage of the area under land use. With regard to erosion, for example, *discussion paper 1* relates that human impact may be substantial under stable geologic conditions, while in areas with steep slopes, and frequent torrential rainfall events, land use impacts may be small compared to natural erosion rates. Can we arrive at similar statements for other impacts?

6. How does the relative importance of the impact change with the size of the watershed?

Scale issues, both spatial and temporal, are very important when considering linkages between land use and water resources. The issue of scale is of critical importance for policy decision and a clear understanding of the processes is paramount to the correct assessment of land-water interactions.

With regard to spatial scale, *background paper 1* asserts that at smaller scales there is a relatively greater likelihood for land use to have an impact both on peak flow and time of peak. The paper proposes the hypothesis that land use impacts on water quantity and sediment can mostly be observed in smaller watersheds. *Background paper 2* maintains that

some quality aspects such as salinity or persistent pesticides may have impacts at larger, even global, scales due to their accumulative nature.

Temporal scales also imply a great variability with regard to land use impacts. *Background paper 2* points out that while some impacts such as bacterial contamination bacteria or pesticides may surface in less than one year, other impacts such as the effect of a growing forest on water availability may take decades. Similarly, the time scale for remediation measures of negative impacts to take effect vary considerably. It seems that that in most cases, the time for remediation takes much longer than that of the initial impact (*background paper 2*).

Can we classify land-water linkages according to their relevance in different spatial and temporal scales? *Discussion paper 1* and *background paper 2* propose such clarifications, but they certainly need to be validated. Should the discussion, as proposed by the organisers, focus on watersheds of small to medium scale up to a size of a few hundred km^2? Are there any indications that large scale events, such as the recent floods in Mozambique, have been notably influenced by changing land use patterns, as many have claimed?

7. Is our knowledge and understanding adequate in regard to the environmental processes involved in land-water linkages?

The discussion on the previous points may help us to identify significant gaps in our knowledge regarding land use impacts on water resources. Which are these, and what research activities can fill these gaps? Maybe, however, the problem lies more in recognising and bringing to light existing knowledge and translating it into policy or programmes of integrated land and water management, as *background paper 1* postulates?

Session 2: Assessing and perceiving land-water linkages

8. Which tools and methods exist to assess the relation between land use and water resources?

The impacts of forests on river hydrology have been traditionally determined through paired watershed experiments. Analysis of time-series hydrological data, in connection with land use maps or GIS, can answer questions regarding the impact of land use on water availability at different scales. *Background paper 3* describes an approach to assess hydrological and water quality data using community-based monitoring techniques. Which tools and methods can we identify in this forum?

9. Which parameters and indicators can be used to measure land use impacts on water resources?

There are many parameters associated with land-water linkages. One challenge is to identify indicators which are easy to monitor while providing significant and accurate information with regard to the important land-water interactions. Is it possible to identify a few "core" parameters and indicators for the identification of key land use impacts? *Background paper 3* describes a methodology for a participatory identification of meaningful indicators. How can we measure the magnitude of impacts on living aquatic resources?

10. What are the technical and financial constraints in assessing land use impacts?

The long-term monitoring of land use, streamflow, and water quality may be a difficult task. In rural areas, especially in developing countries, such data may be costly to obtain. *Background paper 3* describes the application of a participatory methodology based on local know-how to identify relevant parameters to assess the impact of land use change in a Philippine watershed. Are the results of such low-cost monitoring techniques comparable to conventional laboratory techniques, and are they accurate enough to assess the impact of changing land use impacts?

11. What is the relation between perceived and real impact? How can we best deal with variability and uncertainty in assessing land-water linkages?

With regard to land use impacts on water resources, the gap between perceived and assessed impact seems to be quite big. What could be seen as "common sense" and logical may not hold true when scrutinised by scientific analysis. *Background paper 1* identifies seven "mother statements" with regard to the impacts of forested watersheds, some of which lack a scientific base, and could never be demonstrated, e.g. "forests increase runoff", or "forests decrease erosion". Can we identify other cases where there is a difference between myth and reality with regard to land-water linkages?

What are the reasons for these discrepancies? *Discussion paper 1* argues that the difficulty of separating natural and human-induced impacts, the disregard for the various factors which shape land use impacts, and the "hidden" nature of some land use impacts, for example in the case of agricultural non-point source pollution, contribute to the emergence of myths about land-water linkages.

When they influence policies and programmes, or in watersheds divided by political boundaries, such misconceptions about land-water linkages may have serious consequences. *Background paper 1* gives examples from Panama and Sri Lanka, where land use policies or projects designed to have positive impacts on downstream water resources may actually have negative impacts. Another example: Carbon sequestration programmes, which provide incentives for widespread afforestation, may have negative impacts on water resources availability downstream. As *background paper 1* reports, the costs associated with these impacts may be higher than the benefits associated with carbon sequestration. How can land-water linkages be adequately dealt with in such programmes?

The variability and uncertainty of the occurrence of land-water interactions may pose another problem for the assessment of land-use impacts. How can these factors be taken into account?

12. What is the importance of time in the assessment and perception of land use impacts?

Time is a crucial factor in the assessment and the management of land use impacts on water resources. For those practices which have a noticeable effect only after a longer period (several years), for example sediment yield, extensive, long-term monitoring of the parameters may be required. Monitoring over a short period may not detect the impact of the current land use or land use change, but that of decades back. The same applies to monitoring

of the impacts from remedial measures. The time lag associated with many impacts such as sedimentation may affect the perception of these processes: The state of water resources may be associated with current land use practices, while the impact of these practices may be noticeable only after a long time. Can we identify situations where such effects have been observed? What consequences need to be drawn for the assessment of land use impacts on water resources?

Part II: Land-Water Linkages – The Lifescape Perspective

In a watershed context, the benefits of improved land management, or, conversely, the costs associated with negative impacts of inadequate land use on water resources – provided they are significant –, might not only be felt by land users who cause them, but also by others who live downstream or make use of the affected groundwater resources. Thus, there is a need to explore institutional, economic, regulatory, and social instruments which can be applied to achieve an equitable sharing of these benefits and costs by upstream and downstream resource users in a watershed. The third session will deal with assessing benefits and costs to water users resulting from land use impacts on water resources. In the fourth session, the discussion will focus on instruments and mechanisms to share these benefits and costs among resource users in the watershed and for an integration of land and water management at the watershed scale.

Session 3: Valuing land-water linkages

13. Which direct water uses such as domestic use and irrigation are positively or negatively affected by impacts of land use on water resources, and how? Which indirect uses of water such as fisheries, flood control, recreation and, self-cleaning capacity, are positively and negatively affected, and how?

Background paper 4 provides a classification of direct use values and indirect water use values of water resources. *Background paper 5* provides examples how soil and water conservation can affect downstream users such as irrigation both directly e.g. through reduced sediment load and indirectly, by reduced flooding and higher dry-season flows. *Discussion paper 2* describes the experience of New York City, where domestic water supply is affected by impacts of upstream agricultural and other economic activities. On a smaller scale, *background paper 3* notes impacts on drinking water supplies due to increased sediment load and bacteriological contamination, as well as an increased hazard to dwellings of riverine communities due to increased flood events as a consequence of changed land use patterns upstream in the Latanpan region (Philippines). What is the experience with land use impacts affecting water uses in other parts of the world? With the joint experience of the workshop forum, can we develop a matrix illustrating the impacts of upstream land use on direct and indirect water uses downstream in a watershed context?

14. How can we value these different effects in terms of benefits or costs for downstream users?

Background paper 4 provides an overview of different valuation techniques for environmental services of water resources which can be applied to value downstream costs and benefits associated with land use impacts on water resources. The resulting (monetary) values can be included in a conventional cost-benefit analysis. *Background paper 5* illustrates two examples of the economic valuation of downstream effects of soil and water conservation activities in Morocco and Indonesia. Can the forum participants relate other experiences with land use impacts on water resources? What role do uncertainty and variability of land use impacts play in the valuation process? How do we deal with values which are difficult to express in monetary terms, such as cultural or existence values?

15. What is the importance of temporal and spatial scale in valuing land use impacts on water resources?

Time plays a major role in the valuation of land use related impacts on water resources. If there is a significant time lag between a change in land use and the resulting impact downstream, the resulting benefits and costs may be small if future benefits and costs are discounted. Due to the long time lag between erosion and sedimentation, for example, the hydrological benefits of forest preservation in tropical areas may be very small from an economic point of view.

Spatial scale needs to be considered in the valuation of land use impacts as well. With regard to some land use impacts, i.e. impacts on hydrological regime and sediment transport, there seems to be an inverse relationship between the scale in which the impacts can be observed and the scale in which the redistribution of benefits might be important. While these impacts can be most readily felt in small spatial scales, the number of water users who might benefit or suffer from a land use change increases with the size of the watershed. Due to the decreasing magnitude of impact, however, the respective costs and benefits to the individual user may be small. How can we factor spatial and temporal scale into the valuation of land use impacts on water resources?

Session 4: Sharing benefits and costs resulting from land-water links

16. What types of mechanisms and instruments, including use rights, access arrangements, incentives, and awareness building, can be used to link upstream and downstream users in different socio-economic contexts and at different watershed scales?

Discussion paper 2 suggests a categorisation of instruments and mechanisms which can be employed to distribute benefits and costs resulting from land use impacts among land and water users. It identifies examples of the application of such instruments mostly in industrialised countries. *Background paper 4* describes the application of taxes to finance watershed protection activities in the state of Paraná, Brazil, and the collection of watershed protection fees in Colombia. The application of instruments for upstream-downstream linkages depends very much on the institutional and legal environment, the land tenure arrangements, and the access arrangements for water. The workshop forum is invited to comment on, amend and improve the typology and provide concrete examples for the application of such mechanisms.

17. What examples of such mechanisms and instruments have yielded promising results?

Some of the programs described in *discussion paper 2* and *background paper 4* have yielded promising results. In the case of New York City, for example, the city avoided having to build a 6 billion US$ water treatment plant by financing upstream measures for water quality preservation that amounted to a tenth of the costs. *Background paper 4* reports that in the case of Brazil, the environmental tax for watershed protection measures has led to an improvement of water quality in those areas where projects have been financed by the revenues. Can we identify other successful experiences?

18. What are the main constraints to implementation of these mechanisms?

There are various problems with the implementation of mechanisms and instruments linking upstream and downstream resource users. In *discussion paper 2*, it is suggested that one major constraint is the inadequate institutional or organisational capacity for the implementation of such instruments. In India and Sri Lanka, the "scaling-up" of community-based natural resource management schemes to a watershed level has proven difficult because of the lack of inter-community institutions.

Another constraint may be posed by unclear or inexistent property rights for land and water. In poor rural areas, downstream users may not have the capacity to compensate for potential benefits from upstream land use change. Which main constraints can we identify based on experience in watershed-based land and water management? How can land use impacts on downstream water users be taken into account in land and water management approaches at community- or micro-watershed scales? What is the current practice?

19. What are criteria of success for the implementation of such mechanisms?

Discussion paper 2 proposes a set of criteria for the successful implementation of land-water linkages: (i) The impact of upstream land use on downstream water use is well understood. (ii) The impact of land use on water resources clearly dominates over natural impacts or other anthropogenic impacts. (iii) The groups of upstream and downstream stakeholders are few and well-organized. (iv) The economic impact of land use on downstream stakeholders can be quantified. (v) The difference in costs between alternatives must be high enough to provide an incentive to the users for participation in the linkage program. (vi) There is political commitment to establish upstream-downstream linkages. (vii) There is a strong institutional and legal framework which allows the implementation of linkage instruments. The forum may want to review, modify and amend these criteria based on the participants' experience and expertise.

Part III: Land-Water Linkages - The Way Forward

Session 5: Conclusions and recommendations

In the last session, the workshop forum is asked to draw conclusions from the previous discussions and formulate recommendations from the workshop for further work in the field of watershed-based land and water management in rural areas. Whenever possible, recommendations should be directed at specific actors who play a role in the field such as

- researchers: hydrologists, economists, ...
- policy makers
- local resource managers
- development agencies
- international organizations
- other actors...

The following questions may help focus the discussion in the final session.

Can we prioritise land use impacts on water resources that should be the focus of further work on the issue?

Can we identify regions, climate zones, and socio-economic conditions, in which land-water linkages play an especially important role and need to be addressed as a matter of priority?

Can we identify successful tools and methods to value impacts of upstream land use on downstream water resources?

Can we identify successful or promising mechanisms and instruments to share benefits and costs resulting from land-water linkages by upstream and downstream people which should be focused on in further work on the issue?

Can we identify criteria of success for the implementation of such mechanisms and instruments?

Are current land and water management guidelines adequately addressing land-water linkages?

How can the feed back between local know-how, scientific knowledge and policy decisions with regard to land-water linkages be improved?