Land Use Land Cover Changes in the Indo-Gangetic Plains - Data Related Issues

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Edited by:
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1. BACKGROUND

1.1 Sponsor

The meeting was sponsored by and a component activity of the NELDA (European and International Research Network for Land Use/Cover Change Data Development) project, an initiative sponsored and funded by ENRICH, the European Network for Research in Global Change. The objectives of this project are, to:

- Create an international and multidisciplinary collaborating framework for the definition of data requirement and priorities for Land Use and Land Cover Change research as well as for conceptual design of specific data products.
- Promote collaboration and establishment of an international net-working between European and the South Asian LUCC scientific community by holding three expert meetings in concrete regions where important LUCC processes are occurring.

The present meeting, Land Use Land Cover Changes in the Indo-Gangetic plains – Data Issues, is the third in this series by NELDA. The other two meetings addressed the Data issues in relation to the Hindu-Kush Himalayas and the Coastal Zones of Southern India.

Cosponsor

The meeting was cosponsored by SASCOM, the South Asian Planning Committee of START (The Global Change System for Analysis, Research and Training Programme). START is jointly sponsored by the three major programmes devoted to scientific studies of Global Change e.g. International Geosphere Biosphere Programme (IGBP), the World Climate Research Programme (WCRP) and the Human Dimensions of Global Environmental Change Programme (HDP) and is supported by UN and ICSU. The main objective of START is to promote capacity building to enable the region’s scientific community to participate and contribute to the Global Change Programme. In the past couple of years SASCOM has organized activities relating to Land Use Cover Changes in the Indo-Gangetic Plains in relation to the food security issues of the region. Thus awareness of the issues generated among natural and social scientific community through past SASCOM efforts was an important input for the Expert Meeting.

1.2 Land Use Cover Change Project (LUCC)

The aim of NELDA initiative is to improve the data and information availability for LUCC, research programme sponsored jointly by IGBP and IHDP, the two of the three Global Change Programmes. LUCC is an internationally coordinated effort aimed to improve the understanding of the dynamics of land use and land cover change globally with focus in improving the ability to project such change.
Land Use and Land Cover Changes will continue to be the most important components of global change over the next several decades. Yet our understanding of the patterns and processes of land use/cover change is highly inadequate. LUCC a core project of IGBP (jointly with IHDP) aims to remedy this situation through a vigorous research effort to understand the fundamental patterns and processes of land use and cover changes taking into account biophysical, socioeconomic and demographic factors. The research also aims at developing both empirical, diagnostic and integrated models with predictive capabilities for assessments of environmental security and vulnerability. The five overarching questions which LUCC research addresses are:

- How has the land cover changed by human use over the last 300 years?
- What are the major human causes of land use change in different geographical and historical contexts?
- How will changes in land use affect land cover in the next 50 to 100 years?
- How do human and biophysical dynamics affect sustainability of specific types of land use?
- How might changes in climate and global biogeochemistry affect both land use and cover and vice-versa?

The implementation strategy of the LUCC Project emphasizes following main elements:

- Regional approach – This is central to the implementation of LUCC research agenda. Since human activity is currently the main driver of change, it is important to involve local scientists who are well aware of the complex interactions between driving forces and human action in the specific region. Involvement of local scientists is also crucial to ensure that results of scientific investigation can be translated into meaningful policies.

- A coordinated effort across sample of cases in the region characterized by different biophysical endowments and contrasting socio-economic traditions is necessary to generate knowledge, data on land use – land cover change processes and models which are sensitive to regional variability and are effective in identifying best points of policy intervention.

- A major challenge facing LUCC research is the creation of a research framework integrating both social and natural sciences. To formalize this approach a specific effort on data is essential. The formulation and test of complex hypothesis on land use/land cover changes is underpinned by appropriate and suitable data sets.

The broad objectives of LUCC Science plan are to:

- Obtain a better understanding of global land use and land cover driving forces.
- Investigate and document temporal and geographical dynamics of land use and land cover.
- Define the links between sustainability of various land uses and
- Understand the interrelationship between LUCC, biogeochemistry and climate.

Research Programme to achieve these objectives will lead to an improvement in the development of regional and global models and projections of land use and land cover changes.

1.3 Indo Gangetic Plains Region

This region is of major importance for the food security of South Asia. Increased food grains production and crop productivity in the past three decades has brought about virtual self-sufficiency of foodgrains for the countries of the region. Not only is the region able to feed its vast resident population but also contributes very significantly to the needs of population outside the IGP region.

Increased production and productivity that characterized the Green Revolution of 70’s and 80’s came about due to a combination of factors – most important being expansion of irrigated areas by harnessing surface and ground water resources, introduction and spread of dwarf high yielding crop varieties, especially these of rice and wheat, increased use of inputs including fertilizers and plant protection chemicals together with expansion and strengthening of services, fiscal support policies, etc.

Of late evidence is accumulating to suggest that high productivity and growth rates achieved during the Green Revolution era are no longer being sustained to meet the needs of still increasing population in the region. Past growth sources have nearly exhausted. There is no scope for expansion of cropland. Indeed pressure for competing land uses will likely reduce area under foodgrain crops. Investments in irrigation development are unattractive and have declined. Shrinking natural resource base (per capita availability of land/water devoted to agriculture), declining quality of resources and environmental degradation issues will imply increasing threat to our ability to meet the basic needs of the growing population of the region.

In addition to the productivity-related issues a range of social and economic factors will impact land use and therefore the food security. Competing uses for water would force shifts in crops/cropping pattern. Markets for high value crops would be an incentive for farmers to shift from traditional foodgrain crops. An in-depth understanding of biophysical, social and economic factors will be important to understand the nature and complexity of forces driving the change and how these implicate the concerns for food security of the region.

2. THE EXPERT MEETING

2.1 Organization

The expert meeting was organized jointly by the Centre for Advancement of Sustainable Agriculture (CASA). A committee consisting of the following assisted in planning and steering of deliberations.
2.2 Objectives

The following objectives were set out for the Expert Meeting:

1. Achieve an agreement on a broad conceptual multi-disciplinary framework for research on Land Use Land Cover Change in Indo-Gangetic Plains within the overarching theme of food security of the region.

2. Suggest an assortment of Land Use Land Cover Change related projects addressing one or more critical issues within the above framework.

3. Review the metadata on Indo-Gangetic Plains under preparation currently to articulate and prioritize specific data needs on biophysical and socioeconomic parameters critical to understanding of land-use dynamics in the region.

4. Discuss and define strategies and research needs for tackling the broader crosscutting data issues, such as, scaling, data harmonization and validation for the purpose of integrated analysis.

5. Conceive mechanisms for regional synthesis, data consolidation, assessment and facilitation for supporting an assortment of IGP-Land Use Land Cover Change related research projects.

6. Consider ways of promoting continuing interaction between the South Asian and European LUCC scientific communities.

2.3 Participation

The meeting was attended by about 50 scientists representing a range of Institutions within and outside India. These included three scientists each from Bangladesh and Nepal, Dr. Guenther Fisher LUCC Focus 3 leader, Dr. M. Nakayama from the Tokyo University of Technology and Dr. Carlos R. Machedo from the Universidad Atlantica in Portugal. The complete list of participants along with their contact address is appended.
2.4 Programme

The Expert Meeting Programme was organized as per Annexure. Essentially the programme included brief presentations by the participants, and discussions in the working groups to develop recommendation in tune with the objectives of the meeting. Presentations helped in bringing to the fore a variety of issues which have implications for the sustainability of agriculture and food security of the region; requirements and availability of data, current efforts and available regional expertise in modeling events of land ecosystems and crop yields in the Indo-Gangetic Plains and most importantly, requirements for LUCC modeling that would eventually tie up available data with projections of land use scenario.

The Metadata directory for the Indian portion of the Indo-Gangetic Plains compiled as an input for the Expert Meeting was presented. Following the presentations participants broke into following working groups to deliberate and to come up with recommendations relating to the respective themes. The recommendations of the Expert Meeting was presented and endorsed in the concluding session, chaired by Dr. G.B. Singh, Deputy Director General in the Indian Council of Agricultural Research.

3. RECOMMENDATIONS

Following is a summary of recommendations in respect of each group.

3.1 Major Themes and Priority Issues for Setting up a Conceptual Framework of Research

A matrix of issues flagged by Dr. R.K. Gupta in the introductory session served as a preliminary input. These and other issues highlighted by other speakers were considered by the working group. Four major themes and the priority issues in respect of each, endorsed in the concluding session are as below.

**Theme I - Environmental Degradation in High Productivity Areas**

These areas comprise the northwest parts of the indo-gangetic plains comprising the Indian states of Punjab, Haryana and Western Uttar Pradesh and the adjoining region in Pakistan.

**Issues**

- Plataueing of or declining crop yields and declining factor productivity.
- Changes in groundwater regimes (e.g. declining water tables in some and rising water tables in other area) and quality (salinity, toxic contaminants, pesticides etc.) Excess irrigation induced waterlogging.
- Land Degradation as reflected in declining soil quality, soil salinization, nutrient depletions, loss in biodiversity, water quality, degradation, etc.
Need for developing indicators of land quality and monitoring of state of natural resources.

Competing use of land for growing food crops vis a vis increasing significance of livestock in household economy.

Price policy and input subsidy induced changes in cropping pattern.

Developed infrastructure with inadequate regulatory mechanisms to prevent over exploitation of natural resources (organization structure at local level, water users association, concern for preservation of and quality of natural resources).

Liberalized economic regime, trade opportunities impacting cropping patterns.

Institutions, particularly the role of corporations to enter commercial/contract farming.

Need for enhanced Research and Development efforts and organizational set-up to promote sustainable management options to improve environmental quality e.g. promotion of organics and biofertilizers, biopesticides etc.

**Theme II - Highland Ecological Degradation**

Natural resource degradation and its socio-economic consequences in the adjacent mountainous areas can significantly impact sustainability of the production systems in the plains. Some issues of importance include:

- Deforestation, forest fires and denudation leading to loss in biodiversity, extensive erosion, increased run off, river sedimentation and landslides impacting down stream resource endowments.

- Excessive dependence of upland population on agriculture.

- Population influx in the Tarai region.

- Inadequacy of local institutions and regulation on use of common property resources in up-land areas leading to over exploitation of natural resources).

- R & D efforts to enhance productivity, livestock improvement.

**Theme III - Flood Prone Continued Low Productivity Areas - Hazards and Environmental Risks**

Enhancing the continued low productivity in the eastern gangetic plains is a major challenge. Some of the basic issues involved include:

- Shift of river courses, bank erosion, sand/silt casting; emergence and extension of gullies and ravines damage to infrastructure.

- Abandoning of traditional water storage structures and changes in land use causing
extensive flooding and water logging impacting cropping patterns and productivity.

- Small and fragmented holdings; limited capacity to adopt technology and invest in agriculture and allied activities.
- Uncertain environment for investment, wealth accumulation and innovation.
- Weak infrastructure and institutional support; public price policy is of little or no benefit to the farmers; local institutions in disarray and need for support.
- Need for focussed study on Diara lands and related socio-economic problems.

**Theme IV - Land and Water Degradation in the Metropolitan Fringe**

Indo-gangetic plains is one of the most densely populated regions in the world. Fast growing urban centres are impacting land use for agriculture in a number of ways. Some of the important issues, being

- Urban sprawl leading to conversion of agricultural land to non-agricultural uses.
- Location of industrial estates, depletion and pollution of ground water, air and noise pollution, concentration of slums.
- Waste disposal.
- Weak linkages of farm and non-farm activities in the country side; out migration.
- Weak institutional mechanisms/implementation of land use policies and devolution of financial powers to local institutions (municipality, nagar palika etc.)
- Neglect of social sector; health, education and social security.

**Data Issues Common to all the Four Themes:**

(i) Hypotheses relating to each of the themes need to be developed and empirically tested. Accordingly, historical database on a minimum set of important variables needs to be developed.

(ii) Weigh costs and benefits of taking administrative units vs. natural/ecological units in terms of availability of consistent spatial and temporal data sets. Consider imperatives of data acquisition.

(iii) Incorporate effect of palaeo-channels (even if outside IGP but affecting the region) on unit of study.

(iv) Pay special attention to selection of benchmark sites in the lower Gangetic-plains (West Bengal Region).
3.2 Approach for Building up Modeling Efforts in the Region to Address the Highlighted Issues.

Taking into account the themes and issues listed in 3.1, the group recommended the following approaches:

**Essential Preparatory Work**
- Need to integrate modeling efforts from the outset.
- Set up a modeling support group to
  - Review available models/methodologies in relation to themes/issues identified in 3.1.
  - Service/advise IGP modeling community through
    - Capacity building
    - Networking with IGBP and IHDP modeling efforts, International Project and Focus Offices.
    - Link up with the Data Group, formulate data needs, and facilitate data accessibility.
    - Assist access-modeling tools.

**Elements of Modeling Analysis**
- Establish consensus and understanding of past LU/LC changes and ‘driving forces’ through statistical and pattern change analysis.
- Farm household modeling for a representative set of bio-physical/socioeconomic ‘situations’ across the IGP i.e. ‘process to pattern’ linkage; gap analysis.
- Watershed - level modeling, including elements such as
  - Hydrology
  - Crop productivity
  - Degradation processes
  - Nutrient transport/sediment transport.
    (Nutrient balances; Bio-geochemical cycles; Hydrological cycle)
- Multi-criteria model analysis/decision support to address synergies/antagonism regarding resource use, land use, environmental changes.
- Bio-economic models to address food demand - supply - resource - environment linkages in IGP for a range of policy scenarios.
  (Food security and Trade regimes)
Workshop Report
Land use Land Cover Changes in the Indo-Gangetic Plains - Data Related Issues

- Scenarios development in relation to
  - policies
  - external influences
  - climate change

Relevant Time-Scales for Modeling Analysis
The time-scale of the modeling analysis is specific to the theme.

- Special attention is needed to understand LU changes during last 50 years.
- Some themes require longer time span for process understanding e.g. ‘High-land ecological degradation’ requires 100-150 years ‘Flood-prone areas’ should include a paleo-component for better understanding.
- Time frame should be re-visited and decided early on in respect of each theme/issue.
- For future forecasting/projection a 30-50 year time-horizon is most appropriate for IGP-LUCC studies.
- Longer time-horizon may be needed for selected analyses e.g. climate change.

Linkages that Must be Exercised in LUCC Relevant Modeling Efforts
Emphasize linkage to IGBP and IHDP research agendas

- Bio-geochemical cycles
  - carbon issues (energy use; deforestation, aorestation)
  - fertilizer use (nitrogen cycle)
  - greenhouse gas emissions (rice cultivation; ruminants)
  - nutrient transport in the watershed
- Transition to a sustainable world.
- Critical regions and vulnerable places.

In particular linkage with the following programmes will add value to the global change context.

- Land Use Cover Change (LUCC)
- Global Change and Terrestrial Ecosystem (GCTE)
- Biosphere Aspects of Hydrological Cycle (BAHC)
- Land Ocean Interaction in the Coastal Zone (LOICZ)
3.3 Data Sources, Availability, Scales, Harmonization and Format

Data Sources
Some of the major sources include

- Historical data
  - Statistical data
  - Survey of India
  - Settlement records
  - Historical documents - e.g. District Gazetteers.

- Current data
  - Statistical data - Revenue statistics
  - Remote sensing
  - Arial photographs
  - National Sample Surveys (NSS)
  - Maps/reports from line departments

Data Availability Sources
Some of the major data and their source of availability are indicated below:

- Topography (various scales)
  Survey of India

- Remote Sensing (different scales)
  National Remote Sensing Agency

- Geology
  Geological Survey of India (1:250000, 1:50000; specific areas)
  National Remote Sensing Agency (1:250000)
  Sate Geology Departments

- Hydrogeology (ground water)
  Central Ground Water Board
  National Remote Sensing Agency (1:250,000)
  State Ground Water Board

- Soils and Land Degradation
  National Bureau of Soil Survey and Land Use Planning (1:250,000)
  All India Soil and Land Use Survey (detailed maps)
  National Remote Sensing Agency (1:50,000)
  State Soil Survey Units
  State Remote Sensing Centres (1:50,000)
**Forest/Vegetation types**
- Forest Survey of India (1:50,000)
- State Forest Departments
- National Remote Sensing Agency (1:50,000)
- State Remote Sensing Centres (1:50,000)

**Crop Statistics**
- State DES/Department of Economics and Statistics, Departments of Agriculture
- CAPE Project of Department of Space

**Water Resources**
- Central Water Commission
- State Irrigation Departments, Command Areas Development Authority (1:250,000)

**Land use/Land cover**
- Agricultural Departments of States
- Departments of Economics and Statistics
- National Remote Sensing Agency (1:250,000)

**Wet Lands**
- State Agriculture Departments, BES, Revenue
- SAC
- National Remote Sensing Agency (1:250,000)

**Water/Land**
- National Remote Sensing Agency (1:1m;1:50,000)
- State Agriculture Departments; BES

**Floods/Droughts**
- State Irrigation Departments, State Agriculture Departments, National Flood Commission
- National Remote Sensing Agency (1:250,000)

**Demography**
- Census Departments

**Socio-economic**
- BES, Directorate of Economics & Statistics,
- National Sample Survey
Workshop Report
Land use Land Cover Changes in the Indo-Gangetic Plains - Data Related Issues

● Atlases & Maps of Various
  NATMO, Department of Science and Technology (1:1m)

● Weather Data
  India Meteorology Department, Revenue Statistics, State Agricultural Universities
  Agricultural Research Status

● Pollution
  Central Pollution Control Board, State Pollution Control Board (1:250,000; 1:50,000)
  Central Industrial Technology Research Centre, Lucknow

● Urbanization
  State Departments of Town & Country Planning (1:10,000)
  Metropolitan Cities
  National Remote Sensing Agency (1:12,500)
  Space Applications Agency
  State Remote Sensing Centres

● Cadastral mapping
  Survey and Settlement Land Records Departments (1:2,000 to 1:8,000)

Scales Of Cartographic Data

<table>
<thead>
<tr>
<th>Level</th>
<th>Scale</th>
<th>Minimum mappable unit (3x3 mm equals in area to)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>1 : 1 million</td>
<td>900 ha</td>
</tr>
<tr>
<td>Regional</td>
<td>1 : 250,000</td>
<td>56.25 ha</td>
</tr>
<tr>
<td>District</td>
<td>1 : 50,000</td>
<td>2.50 ha</td>
</tr>
<tr>
<td>Block</td>
<td>1 : 25,000</td>
<td>0.56 ha</td>
</tr>
<tr>
<td>Village</td>
<td>1 : 10,000</td>
<td>0.09 ha</td>
</tr>
<tr>
<td>Farm</td>
<td>1 : 4,000</td>
<td>0.014 ha</td>
</tr>
</tbody>
</table>

For analysis of data and Policy making, 1:50,000 scale maps and quantitative data are required at district level.
Harmonization – Issues and Problems

- Maps of unequal scales
- Maps prepared from different data bases of different dates
- Data transformation – non-spatial to spatial mode
- Old maps and present maps

Data Format

Digital Analog (different scales & resolutions)

Remote Sensing Satellites

Landsat 1972 onwards - 80.0m resolution

SPOT 1982 onwards - 20 and 10m resolution

ERs: SAR 30m C Band. Cloud penetration, day/night – floods

Radarsat: SAR C Band crops in Monsoon

NOAA: 1.1 Km resolution 11 channel, Crop, Vigour, Normalized difference vegetation Index, Drought

I.R.S. 1A 1988 with 73 m (L1) 36.5 (L.2)

1B 1991 with 73 m (L1) 36.5 (L.2)

1C 1995 with 5.8 m (PAN) L-3 23 m MSS WIFS data (180 m)

1D 1997 with 5.8 m (PAN) L-3 23 m MSS WIFS data (180m)

IRS P: Oceansat

Future Satellite Units

Cartosat: 2.5m PAN? MSS: 10?

Resource-sat: 1.0m (?) MSS: 10m?

Aerial (different scales & resolutions)

a. Digital: Scanners

b. Photographs

Map format (SOI Toposheets)

(NATMO Maps/atlastes)

Tables, Statistical, Slides etc.
Problems of Acquiring Data

- Restricted policies
- Update & Monitoring
- Duplication of work
- Data reliability
- Data non-availability, non-accessibility, timely availability
- Cost considerations
- Increase in number of districts – Capability and formatting.

Suggestions

- Initially, the maps on Geology, Hydrogeomorphology, (ground water potential), present Land use/cover, slope, soils, land degradation, water bodies, and the forest (vegetation) maps should be acquired for the project areas selected for LUCC research from the organisations which have prepared. The preferred scales of the maps to be acquired are 1:50,000 and/or larger.

- The maps collected may be digitized and the soft copies of these maps should be made available to the researchers for their project work.

- The maps, if acquired, on different scales, may be harmonized and may be made available in a form compatible with GIS (Arc-info) package.

- The information on attributes data (like, soil analytical data, profile characteristics, climatic etc.) also to be collected and may be made available in GIS compatible form to the researchers.

- The historical data base available, may be fully utilized, for preparing a base document on the temporal trends in land use/cover change (LUCC) for the Indogangetic plains.

3.4 Meta-Data Directory Follow-Up

The group recommends that

- CASA formally request Bangladesh, Nepal and Pakistan to arrange to start compilation of meta-data directory along the lines of the draft directory presented in the Expert Meeting. Drs. Iqbal of SPARRSO and R.R. Sharma of Nepal agreed to initiate such an effort after returning.

- The following databases that are available need to be included in the Directory.
  - Climate Meteorological Data
  - Energy
  - Literature available of current and past policies/plan targets
  - Meta-data on historical data resources (Dr. Satpal Sangwan’s work)
  - Others as per list generated by Data Group.
A judiciously devised indexing system be included to help the users access availability or otherwise of data of his interest related to a specific time period, geographic region or discipline.

Directory be published and distributed in computer floppies for saving cost of printing and duplication and also for ease in updating. When input from other countries is available one could consider cutting CD-ROMS.

The first combined regional version of the met-data directory complete with indexing segment should become available within three months.

CASA should continue to oversee the preparation and release of this regional met-data directory under the overall guidance of Dr. I.P. Abrol suitably assisted by Drs. M.K. Tiwari, N.C. Gautam and M. Velayutham.

3.5 Needed Mechanisms for Continuing Interaction Between Scientists within and outside the Region

Networking

The group suggests networking using electronic media as the way forward. This will be

- Cost effective, speedy and efficient
- Permit better targeting
- Allow for expansion/modification
- Attract interested groups currently not contacted

The main objectives of networking would be to

- Expand IGP research circle by facilitating new entrants
- Enhance IGP-LUCC visibility in other regional and global programmes

Components

Following components are envisaged with active involvement of all the countries of the region:

- Website

  Host - LUCC/IHDP/IGBP - Preferable
  Free Commercial Sites

  Web master
  Professional/Technical Advisor
  Archives of periodicals
  Directories & links
Workshop Report
Land use Land Cover Changes in the Indo-Gangetic Plains - Data Related Issues

- News Group
  Host
  Moderator
  Periodicals/Newsletter
  Sub groups for focus 1, 2 & 3 of the LUCC Project

- Directory (Who is Who in IGP Research)
  Institutions within & outside India
  Individual researchers & groups
  Projects and Events

Nodal Point
In view of initiative already taken and being a non-government organization the group recommends that CASA take up this role under the guidance of Dr. I.P. Abrol and suitably assisted by Dr. M.K. Tiwari.

4. FOLLOW-UP AGREED TO IN THE MEETING

4.1 Assortment of Proposals on Identified Themes and Issues:

All the participants were urged to provide to Dr. I. P. Abrol suggestions for projects that address one or more of issues identified in para 3, or an assortment of projects relating to one of the themes in totality mentioned above. These projects must be doable in a reasonably short frame of time (say 1 to 3 years), subject to availability of resources. Each suggestion sent may contain a concept note delineating steps of research or data gathering involved and who would take the scientific lead, if resources are available. A group of scientists could also suggest a common concept note, if they are interested in handling the project together.

The following assumed the nodal responsibility for coming up with theme-wise proposal concepts:

Theme I: Environmental Degradation in High Productivity Areas
Prof. P. S. Vashishtha
(Dr. M. M. Sarin would provide a concept note on the role of crop intensification on water quality)

Theme II: High Land Ecological Degradation
Dr. S. S. Grewal, Dr. Gopal Krishan and Dr. P. K. Sharma jointly
(The Nepalese delegation would come up with a proposal in consultation with their senior authorities for implementation in their country and send a copy of the same to Dr. I. P. Abrol. It could propose elements of work to be coordinated
with Indian counterparts, where ecoregion/issue cuts across the international boundary)

**Theme III: Flood-prone areas: Hazards and Environmental Risk**

Dr. P. Chakraborti

(The Bangladesh delegation would come up with a proposal in consultation with their senior authorities for implementation in their country and send a copy of the same to Dr. I. P. Abrol. It could propose elements of work to be coordinated with Indian counterparts, where ecoregion/issue cuts across the international boundary)

**Theme IV: Land and Water Degradation in Metropolitan Fringe**

Prof. R. B. Singh

*Cutting across all the Themes – Creating Historical Data-Base for certain regions of IGP: Dr. Satpal Sangwan*

(This proposal has already been prepared and is being processed for raising resources)

Copies of all the concept notes, including those not listed above will be sent to the concerned Theme Nodal persons listed above and also Dr. I. P. Abrol.

*Action: All Participants*

4.2 Data availability, sources and harmonization

The additional data requirements and sources suggested by the Working Group 3 will be considered in the revision of the draft meta-data directory in phases.

*Action: Dr. M.K. Tiwari, Dr. N.C. Gautam and Dr. D.D. Dangwal*

As regards issues of and recommendations on harmonisation, of data from various sources, the matter will be considered on case to case basis in relation to the assortment of projects submitted and accepted for implementation. This working group would be reactivated at an appropriate time.

*Action: Dr. I. P. Abrol and Dr. M. K. Tiwari*

4.3 Modelling Group

Modelling group recommendation will be considered when a few concept notes are generated and picked up for implementation. CASA in consultation with the Steering Committee will also evolve a suitable follow up plan to build the necessary modelling expertise to meet the needs of the proposals that emanate as a result of this Expert Meeting in consultation with Dr. PK Aggarwal, AK Gosain.

*Action: Dr. I. P. Abrol, Prof. Vashishtha and Dr. M. K. Tiwari*
4.4 Meta-Data Directory

The action plan recommended by the concerned Working Group and recorded in Para 3.4 will be implemented.

4.5 Networking

The action plan recommended by the concerned Working Group and recorded in Para 3.5 will be implemented.

4.6 Reporting to SASCOM, NELDA etc.

Arrangements will be made to present Recommendations of this meeting in the forthcoming SASCOM Planning Meeting in February 2000 in Dhaka. The Meta-data Directory will also be made available for reference during the meeting.

*Action: Dr. I. P. Abrol and Dr. M. K. Tiwari*

The outcome of this meeting will also be submitted to NELDA, LUCC, IGBP, IHDP, APN, etc.

*Action: Dr. I. P. Abrol*

4.7 Interaction with National Agricultural Systems in the participating South Asian countries

Bangladesh and Nepal delegations were urged to discuss preparation of relevant projects with SASCOM focal points and also higher authorities of respective organisations to see implementability of projects on identified issues. Dr. I. P. Abrol will do similar consultations with Dr. G. B. Singh, in respect of Indian projects. Recommendations will also be communicated to Dr. Amir Mohammed in Pakistan for initiating similar efforts in Pakistan with respect to the issues identified in this Expert Meeting. The cross country proposals when ready will be discussed with SASCOM, APN, NELDA and other suitable mechanisms. Dr. I. P. Abrol will be kept informed of the progress made in this matter.

*Action: All country contacts*

4.8 Steering Committee

It was agreed that the Steering Committee will continue to oversee implementation of these recommendations. Periodic consultations (once in a couple of months) will be arranged either by meeting, if possible or through exchanges in electronic media.
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