Environmental Education for Ecosystem Conservation

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Centre for Ecological Sciences,
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URL: http://ces.iisc.ernet.in/energy/Welcome.html
Research Area

- Energy – demand, supply, planning
- Wetlands – Conservation, Management
- Ecosystems
- GIS & Remote Sensing
- EIA, Environment Management
- Distance Education
- Environment Education - Schools
Environmental Education - Need

- The cognitive and cultural separation of “ecology and environment” from the human enterprise, has led to large scale degradation and depletion of natural resources.

- The guiding ideology needed to learn and teach sustainability is an ideological orientation that emphasizes conserving cultural values, beliefs, and practices that contribute to sustainable relationships with the environment.
Environmental Education

- **Know Your Ecosystem**
  - An Exclusive Awareness Programme for School Children
    (with KERF, Bangalore)

- Ecosystem monitoring using SIMPUTERS (CSA, IISc)

- **Environmental Engineering Courses: Design, Development and Launching of Courses**

- **Environmental Education Series: Design and development of Series of Learning Materials**
  - School students (VIII, IX, X, XI and XII) and teachers

2/13/2007
IISc Initiatives

• Development of Delivery model for ODL (2004)
• Launching of 2 Courses (Aug – Dec 2004, Jan-May, CCE)
• Environmental Education Series: Design and development of Series of Learning Materials - School students (VIII, IX, X, XI and XII) and teachers
Environmental Education: Background

The United Nations Conference on Environment and Development held in Rio De Janeiro in 1992, and The World Summit on Sustainable Development at Sherbet in 2002 have drawn the attention of people around the globe to the developing condition of our environment.

In order to achieve the goals of sustainable development, people need to become aware of the environmental issues and acquire background information to enable them to make and influence decisions.
Environmental Education

• Environmental education is thus concerned with attitude towards, and decisions about environment quality; with informed management of resources; and with the ethical considerations that relates to these.
Environmental Education: India

- Recognising the importance of environmental education at all levels, the Hon’ble Supreme Court ruled that a course on Environment be made mandatory at the undergraduate and school levels to sensitize the youth to environmental issues and concerns.
Decade for Education

- The declaration of the decade for Education for Sustainable Development (ESD) beginning 2005, by the United Nations has provided further impetus.

- The goal is to create a sustainable world through active participation of citizens.
EE in India- Goals

- Environmental Education would help to recognize the importance of investigating the environment within the context of human influences, incorporating an examination of economics, culture, political structure, and social equity as well as natural processes and systems. Ultimately, the goal of environmental education is to develop an environmentally literate public.
Environmental Education: Approach

- Environmental education focusing on real-world contexts and issues often begins close to home, encouraging learners to forge connections with and understand their immediate surroundings.

- The awareness, knowledge, and skills needed for these local connections and understandings provide a base for moving out into larger systems, broader issues, and a more sophisticated comprehension of causes, connections, and consequences.
Learning Design

- Education system needs to consider the performance of learners, monitoring and assessment of their progress
- Optimizing opportunities for learning
- Need to shift from Content Centered Approach
- Emphasis need to be on perception than on memory – one’s ability to interact in a specific context
- Context in this case includes people, machines, artefacts, environments, objects and agents, which may interact to establish ecological problem-solving relationships
Environmental Education - IISc Approach

- Environmental Engineering Courses for working professionals
- Environmental Education Modules for School students and teachers (supplements the current curriculum)
Environmental Engineering Courses

• Design and development of Series of Learning Materials in Engineering Sciences for open distance learning
  – Inclusion of student relevant examples
  – directed at practicing professionals in India and the developing Commonwealth countries for continuous professional development
Courses

1. Municipal Solid Wastes Management
2. Ground Water and Soil Pollution from Agricultural Activities
3. Air Pollution Control
4. Municipal Water and Waste Water Treatment
5. Environmental Management
Partners

1. The Indian Institute of Technology – Bombay (IIT-B), Bombay: S.P. Mahajan, Head, Centre for Environmental Science and Engineering, to develop the module on “Air Pollution Control”;

2. The National Environmental Engineering Research Institute (NEERI), Nagpur: Professor R.N. Singh, Director, and Dr. Rakesh Kumar, Senior Assistant Director, to develop the module “Municipal Water and Waste Water Treatment”;
3. Management of Solid Wastes (IISc)

4. Ground Water and Soil Pollution from Agricultural Activities (IISc)

5. Environmental Management (IISc);
Distance Education: INTERNET BASED ENVIRONMENTAL ENGINEERING COURSES

Municipal Solid Waste Management & Environmental Manager

The following two courses are being offered during August – December and January – May sessions at the Indian Institute of Science, Centre for Continuing Education (http://cce.iisc.ernet.in):

1. Environmental Management
2. Municipal Solid Waste Management

Contact Information:

PROFICIENCE Office,
Central Lecture Hall Complex,
Indian Institute of Science,
Bangalore - 560 012.
Course Schedule

- Class room briefing and introductory sessions at the beginnings of the courses (2 -3 days).
- Interactive session through internet (web and email) for two months.
- Mid term exam after third month
- Field work (IV month)
- Final exam at the end of fourth month

2/13/2007
Subject material for courses in distance education is offered in four different modes for the registered students:

- Downloadable mode
- Read only mode
- Interaction through Internet
- Classroom Interaction
Login

Login

Login Name: tvr

Password: ******

Auto-Login: Next time log me in automatically.

Login - Cancel

Forgot your password or login?
My Courses

Help
• Select Browse Courses to view a list of courses on this ATutor server. Access a course and enroll to add that course to your list of Enrolled Courses.
• Select Create a New Course to set up the initial framework for your course. You will be placed into your course framework when you submit the initial setup, after which you may begin adding content. Your new course, and its properties, can be managed on the Tools page, under the heading Instructor Tools.

Create a New Course

Taught Courses
Subject material for courses is offered in four different modes for the registered students:

- Downloadable mode
- Read only mode
- Interaction through Internet
- Classroom Interaction
<table>
<thead>
<tr>
<th>Course Name</th>
<th>Description</th>
<th>Shortcuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Management</td>
<td>This course provides an overview of the key concepts and principles in environmental management, areas of global and national environmental concern, and strategies and tools for effective environmental management. Attempt to understand the genesis of environmental problems, the concerns that leads to various international and national initiatives to tackle them have been made in this course. Various tools, which can be used to address environmental problems and the role that the professionals can play in managing environment in their respective areas would be discussed.</td>
<td></td>
</tr>
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|                         | · Category: TVR  
                         · Access: Private  
                         · Enrolled: 9  
                         · Created: 2004-10-04  
                         · Logins: 193 Details                                      | · Shortcut to Instructor Tools  
                         · Delete                                                   |
| Municipal Solid Waste Management| Rapid population growth and uncontrolled industrial development are seriously degrading the urban and semi-urban environment in many parts of the world, placing enormous strain on natural resources and |
|                         |                                                                                                                                                                                                            | · Shortcut to Instructor Tools  
                         · Delete                                                   |
1 Principles of Environmental Management

Contents:
- 1.1 Ecosystem Concepts
- 1.2 Participants in Env. Mgt.
- 1.3 Ethics and The Environment
- 1.4 International Env. Movement
- 1.5 Env. Concerns in India
- 1.6 Lecture Slides - 1

Export Content
Introducing Municipal Solid Waste
Discussions

Forums
Post, read, and respond to forum messages for this course.

Chat
Chat with others from this course who are online right now.

Inbox
Send and receive private messages. Communicate with individual course members.

Polls
Create and edit polls for this course.

Users Online
Click on a name in the User's Online list to send that person a private message. "Users Online" also appears with the menus, so you can have it open at all times.
<table>
<thead>
<tr>
<th>Environment</th>
<th>Ecology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy I: Principles</td>
<td>Water I: Resources &amp; Concepts</td>
</tr>
<tr>
<td>Energy II: Resources, Consumption &amp; Technologies</td>
<td>Water II: Properties</td>
</tr>
<tr>
<td>Aquatic Biodiversity</td>
<td>Wetland Birds (with identification keys)</td>
</tr>
<tr>
<td>Atmosphere and its Pollution</td>
<td>Soil: Properties and Conservation</td>
</tr>
<tr>
<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Biodiversity</strong></td>
<td><strong>Coastal Ecosystem</strong></td>
</tr>
<tr>
<td><strong>Phytoplanktons</strong></td>
<td><strong>Hydrologic Cycle</strong></td>
</tr>
<tr>
<td><strong>Zooplanktons</strong></td>
<td><strong>Ground Water</strong></td>
</tr>
<tr>
<td><strong>Handbook -Fish</strong></td>
<td><strong>Pollution</strong></td>
</tr>
<tr>
<td><strong>Handbook on Amphibian</strong></td>
<td><strong>Urban Waste Management</strong></td>
</tr>
</tbody>
</table>

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Ecosystem Conservation - Need
Water, water everywhere, 
but not a drop to drink!!.

Floods: Rain, Rain Go away 

Drought: ‘O’ God Give us some water 
(2003,2002....)

Water as an economic good: The Privatization of Water and Water Systems (Access to basic water and sanitation are universal rights, and therefore cannot be negotiated as commodities)

Mismanagement of Water!!!
Global Water Stocks

Distribution of Water:
Total Volume – 1400 million km$^3$
Oceans – 97.2%
Land – 2.8%
Atmosphere – 0.001%

Land – 2.8% of total
  Glaciers and ice caps – 77.4%
  Groundwater – 22.1%
  Surface fresh water – 0.4%
  Soil moisture – 0.2%

Note: of consumable fresh water groundwater is 98%.
The hydrologic cycle: Active model
The hydrologic cycle: Global cycle

Water is Life

Why study the water and energy cycle? Earth is a water planet...

Water in Climate

Water in the environment

Water supply and quality

Water for consumption

Fluxes and Feedbacks
Global Water Consumption

Source: Adapted from Figure 2, Freshwater Series No. A-2, "Water — Here, There and Everywhere".
Water for Rural Development

• More than 1.3 billion people live under absolute poverty

• Majority of the poor are living in rural areas
Increasing Demand for Water

1995

3,572b m3

2025

4,913b m3

X1.4

Source: WMO

2/13/2007
Map showing agricultural water withdrawal as percentage of renewable water resource in 1998 by country, where withdrawals for agriculture are critically high (category 5) and indicative of water stress (category 4).
A new global Water Poverty Index relative standing of 147 countries according to their water poverty
The Water Poverty Index ranks India (WPI=53.2) 47th from the bottom, and China 43rd (WPI=41.1) from the bottom out of 147 countries. Haiti, Malawi, Eritrea, Niger and Ethiopia are the water-poorest countries of the world; Guyana, Norway, Iceland, Canada and Finland are the water richest.

Does Water Poverty have much to do with Water Scarcity?
Figure 1 Correlates of Water Poverty: Water Scarcity or Underdevelopment?

![Graph showing the relationship between Water Poverty Index (WPI) and other indices.](image)

- **Water Poverty Index**
- **Water Resources Index**
- **Human Development Index**

**Equation 1:**
\[ y = 0.1905x + 42.643 \]
\[ R^2 = 0.0004 \]

**Equation 2:**
\[ y = 0.002x + 8.9023 \]
\[ R^2 = 0.6431 \]

Countries in ascending order of HDI:
- Sierra Leone
- Niger
- Burundi
- Burkina Faso
- Ethiopia
- Mozambique
- Guinea-Bissau
- Chad
- Central African Republic
- Mali
- Rwanda
- Guinea
- Switzerland
- Germany
- United Kingdom
- France
- Sweden
- Norway
- USA
- Australia
- Canada

Water Poverty Index is the product of Water Resources Index and Human Development Index.
Wetland ecosystems

• Wetland ecosystems account for about 6% of the global land area and are among the most threatened of all the environmental resources.

• Wetlands have long suffered significant losses and continue to face an on-going conversion threat from industrial, agricultural and residential developments as well as hydrological perturbation, pollution and pollution-related effects.
Wetlands are the \textit{transitional zone} between land and water.

- Uses-intrinsic ecological and environmental values.

Sources of pollution

- Point Sources - municipal and industrial wastewater.
- Non-point Sources - urban and agricultural run-off.

Major degrading factors - eutrophication, siltation, construction, logging and mining activities; contamination by toxic metals such as mercury and organic compounds such as poly-chlorinated biphenyls.
WETLANDS OF BANGALORE

- occupy about 4.8% of the city’s geographical area (640 sq.km).
- decreased from 379 (138 in north and 241 in south) in 1973 to 246 (96-north and 150-south) in 1996.
- decrease of 35.09% - attributed to urbanisation and industrialisation, residential layouts, commercial establishments, sport complexes, etc.
- Selected wetlands were investigated for the water quality – high BOD, Turbidity, high metal content etc.
- Socio economic survey on wetland dependency revealed a value of Rs. 10,457/day/ha for a clean wetland (Rachenahalli) compared to Rs. 20/day/ha for a polluted wetland (Amruthalli)
Water bodies are Interconnected
<table>
<thead>
<tr>
<th>THEN</th>
<th>NOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dharmabudhi kere in subhashnagar</td>
<td>BMTC bus terminal</td>
</tr>
<tr>
<td>Shulay lake</td>
<td>Football stadium</td>
</tr>
<tr>
<td>Kramangala lake</td>
<td>Sports village</td>
</tr>
<tr>
<td>Siddhikatte lake</td>
<td>market</td>
</tr>
<tr>
<td>Chellaghatta lake</td>
<td>Golf course</td>
</tr>
<tr>
<td>Binny mill tank</td>
<td></td>
</tr>
<tr>
<td>Miller tank</td>
<td>Residential layout</td>
</tr>
<tr>
<td>Akkithimmanahalli tank</td>
<td>Near Langford road into a housing colony and a hockey stadium</td>
</tr>
<tr>
<td>Domlur lake</td>
<td>BDA layout</td>
</tr>
<tr>
<td>Sampangi tank</td>
<td>Sports stadium</td>
</tr>
</tbody>
</table>
Implications of Removal of Lakes: Loss of Connectivity -> Impairment in Hydrologic Functions
Fig: 36  Drainage network of Bellandur tank

Scale: 1:50,000
Reference: Survey Of India Toposheets
Wetland Losses

- Agricultural Conversion
- Direct deforestation in watershed
- Hydrologic alteration: Alteration in the structure of watershed -> affects functions: ecological, hydrologic, nutrient recycling....
Chronic Wetland Losses

- Alteration of upper watersheds
- Degradation of water quality
- **Ground water depletion**: decrease in depth of the ground water table from 35-40 to 250-300 feet in 20 years due to the disappearance of wetlands
- **Introduced species** and extinction of native biota
- Due to many anthropogenic activities India supports few important wetlands. **45% of wetlands** in India are considered to be moderately to highly threatened.
Ground-water flow system in the Devils Lake area. (From Pusc, 1993.)
Alteration in Ecological Integrity

- Phytoplankton: 0.025 ppm
- Zooplankton: 0.123 ppm
- Smelt: 1.04 ppm
- Lake Trout: 4.83 ppm
- Herring Gull Eggs: 124 ppm
NOTE:
This is a simplified representation of the food web showing the main pathways. Food (energy) moves in the direction of the arrows. The driving force is sunlight. Depictions of the various organisms are not to scale.
The Solution

• Restoring and conserving the actual source of water - the water cycle and the natural ecosystems that support it - is the basis for sustainable water management;

• Environmental degradation is preventing us from reaching goals of good public health, food security, and better livelihoods world-wide;

• Improving the human quality of life can be achieved in ways that also maintain and enhance environmental quality;

• Reducing greenhouse gases to avoid the dangerous effects of climate change is an integral part of protecting freshwater resources and ecosystems.
Watershed Approach in Resource Management

- Protecting the integrity of permanent and intermittent seeps, streams, rivers, wetlands, riparian areas, etc.
- Prioritising watersheds for protection and restoration and focus available resources on highest priorities. Also, identify sub-watersheds in which to emphasize high water quality.
- Conducting a comprehensive all seasons water quality monitoring.
- Eliminating commercial logging and unrestrained recreation in municipal watersheds
Conceptual basis for Ecosystem Management

- **ECOLOGICAL**
  - Biotic
  - Abiotic factors

- **SOCIO-ECONOMIC**
  - Stake holders
  - Values
  - Issues

- **INSTITUTIONAL**
  - Laws and mandates
  - Staffing and funding

Ecosystem approach
Ecosystem Management is to

• restore and maintain the condition

• sustainability

• biological diversity of ecosystems

• supporting sustainable economies and communities
Ecosystem comprises...

**Biotic components**
- **Autotrophs**
  - Energy fix
  - Selfhelp group
- **Heterotrophs**
  - Transfer energy
  - Dependent
- **Detritivours**

**Abiotic components**
- **Physical**
  - solar radiation, temperature, humidity, etc.,
- **Chemical**
  - soil, water, air, etc.,
Latitudinal Gradient in Species Richness

- Lower latitudes have a higher # of species
- Higher latitudes have a smaller # of species
Geographic Variation in Biodiversity
Energy Transfer

Generalised Energy Pyramid

- Algae: 1000 units
- Phytoplankton: 100 units
- Grazers: 10 units
- Filter Feeders: 1 unit
- First Order Carnivores: 1 unit
- Second Order Carnivores: 1 unit

Four trophic levels are shown. The relative biomass is shown for each level. An ecological efficiency of 10% is assumed for each level.

1,000,000 J of sunlight

10,000 J

100 J

10 J
solar energy

heat

first trophic level
producers (plants)

heat
second trophic level
primary consumers (herbivores)

heat
third trophic level
secondary consumers (carnivores)

heat
fourth trophic level
tertiary consumers (top carnivores)

heat

detritivores (decomposers and detritus feeders)
Ecosystem
HYDROLOGY AND BIODIVERSITY LINKAGES WITH LANDSCAPE DYNAMICS

Hydrology

Biodiversity Ecology

Landscape dynamics Land-cover Land-use

2/13/2007
Landscape

- Interaction
- Material flow
- Energy flow

Structure
- Size
- Shape
- Number
- Types

Function

Changes

Alteration in structure and function
- Hydrological
- Ecological
- Nutrient
Sub-basin wise fragmentation analysis in Sharavathi river basin

Upper catchment

<table>
<thead>
<tr>
<th>Sub-basin</th>
<th>Rainfall (mm)</th>
<th>Forest (%)</th>
<th>Agri-open (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nandi</td>
<td>1715.20</td>
<td>41.4</td>
<td>53</td>
</tr>
<tr>
<td>Haridravathi</td>
<td>1776.49</td>
<td>30.5</td>
<td>64</td>
</tr>
<tr>
<td>Yenne</td>
<td>2157.88</td>
<td>46</td>
<td>46.1</td>
</tr>
<tr>
<td>Hurli</td>
<td>3382.40</td>
<td>42.1</td>
<td>43.2</td>
</tr>
<tr>
<td>Sharavathi</td>
<td>4801.25</td>
<td>65.8</td>
<td>22.7</td>
</tr>
<tr>
<td>Rainfall</td>
<td>4410.05</td>
<td>60.7</td>
<td>27.7</td>
</tr>
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</table>
Sub-basin wise fragmentation analysis in Sharavathi river basin …..

Upper catchment

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<tr>
<th>Rainfall (mm)</th>
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</thead>
<tbody>
<tr>
<td>5597.50</td>
<td>68.7</td>
<td>17.6</td>
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</table>

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<th>Rainfall (mm)</th>
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<tr>
<td>4933.01</td>
<td>57.7</td>
<td>26.4</td>
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</table>
# Sub-basin wise fragmentation analysis in Sharavathi river basin

## Upper catchment

<table>
<thead>
<tr>
<th>Sub-basins</th>
<th>Interior</th>
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<th>Edge</th>
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<th>Patch</th>
<th>Undetermined</th>
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<tbody>
<tr>
<td>Nandiholé</td>
<td>9.58</td>
<td>19.37</td>
<td>7.15</td>
<td>10.85</td>
<td>52.95</td>
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<td>Haridravathi</td>
<td>5.02</td>
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<td>10.76</td>
<td>65.6</td>
<td>0.1</td>
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<tr>
<td>Mavinaholé</td>
<td>9.96</td>
<td>21.26</td>
<td>7.83</td>
<td>13.38</td>
<td>47.42</td>
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<tr>
<td>Sharavathi</td>
<td>8.09</td>
<td>18.96</td>
<td>6.27</td>
<td>15.06</td>
<td>51.54</td>
<td>0.08</td>
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<tr>
<td>Hilkunji</td>
<td>21.02</td>
<td>32.98</td>
<td>8.52</td>
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<td>24.86</td>
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<td>14.43</td>
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<td>10.12</td>
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## Lower catchment

<table>
<thead>
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<th>Sub-basins</th>
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<th>Perforated</th>
<th>Edge</th>
<th>Transitional</th>
<th>Patch</th>
<th>Undetermined</th>
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<tr>
<td>Chandavar</td>
<td>10.23</td>
<td>25.46</td>
<td>6.44</td>
<td>14.99</td>
<td>42.75</td>
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<tr>
<td>Haddinbal</td>
<td>4.2</td>
<td>19.24</td>
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<td>53.07</td>
<td>0.11</td>
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2/13/2007
Forest fragmentation and stream status

<table>
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<tr>
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<th>Patch</th>
<th>Forest (%)</th>
<th>% E-Sevg</th>
<th>Rainfall (mm)</th>
<th>Stream*</th>
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<td>4933.01</td>
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</table>

* A = Perennial, all 12 months; B = Seasonal, 9 months; C = Seasonal, 6 months; D = Seasonal, 3-4 months

Correlation coefficient (r) at P < 0.05

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<thead>
<tr>
<th></th>
<th>Rainfall (mm)</th>
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<tr>
<td>Agri-open (%)</td>
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<td>-0.982</td>
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<table>
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<td>Evg-Sevg</td>
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<td>M-deciduous</td>
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<td>%tree endemic</td>
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<td>H’</td>
<td>0.702</td>
<td>-0.707</td>
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</table>
Groundwater

- Water table (higher in wet season, lower in dry season)
- Unsaturated zone
- Saturated zone only in wet season
- Saturated zone
- Well water level varies with seasons
- General motion of groundwater
- Groundwater discharges through riverbed in both wet and dry seasons
- Groundwater discharge from spring only in wet season
Groundwater Recharge
Natural forests Vs Other land-uses

• Forests Regulate flows (perennial streams)
• Increased Infiltration will lead to higher soil water recharge and increased dry season flows
• Reduces intensity of overland flow and hence reduces sediment transport
• Binding effects on tree roots enhance slope stability (that reduces erosion)
• Groundwater recharge
• Biodiversity
This is our contribution to the society that has been possible by the support and encouragement from many individuals and institutions.

Thank You
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