Unit IV Information Management

Complex Systems

Environment is a complex system of manifold interacting components. Such complex systems are highly variable in space and time, with every manifestation tending to be unique. Thus the track of every new cyclone in the Bay of Bengal differs from that of every previous one and every wheat field has a slightly different composition of associated weeds, fungi, nematodes, insects and mites. So information about environment cannot be collected within the confines of a laboratory, although specific environmental parameters like nitrate concentration in water may be determined in the laboratory. Instead, extensive information needs to be collected under field conditions. This is difficult to be accomplished properly through centralised machinery, although this is the current mode of operation. Thus various Pollution Control Boards collect data on the quality of water in rivers, or Wild Life Wings collect data on number of tigers. As has recently been brought out this often tends to be unreliable data of poor quality, besides posing difficulty of access to the general public. The major shortcoming of this system of data collection through centralised machinery is that it is not open to public scrutiny and correction in the spirit of science. It would obviously be desirable to improve on the current system in a number of ways.

Such an alternative, more effective system needs to incorporate:

1. Extensive network of observers over space
2. Continual observations in time

3. Collection of data in a transparent manner by employing proper methodology
4. Careful scrutiny of data put out in public domain
5. System of correcting any errors

Collaborative Knowledge Generation

Recent advances in Information and Communication Technology facilitating easy communication and management of enormous quantities of information has opened up possibilities of collaborative knowledge generation. Collectively known as Web 2.0 technologies, these developments make possible participation by a wide range of people, not necessarily possessing technical expertise. Thus school students, teachers and amateur fishermen are today engaged in several programmes of river watch in Canada. The ambitious Encyclopaedia of Life project visualises extensive inputs from "Citizen Science" and "School Science".

All over the world, citizens constitute an extensive network of observers engaged in continual surveillance of many facets of their environment. In this they may be motivated in many different ways. For example,

1. Students may be required to undertake academic projects, as they now are at all stages of education in India. A system has been put in place in Canada to take advantage of such activities in the river watch programmes.
2. Ordinary people may be engaged in observing different aspects of environment during their pursuit of livelihoods, e.g., medicine men (status of medicinal plants and associated ecosystems) or rickshaw drivers/pullers (status of road surface and associated traffic).
3. Ordinary people may have an interest in specific aspects of the quality of their environment, e.g., asthma patients in the quality of air.
4. Amateur naturalists like bird watchers have world over collected extensive information on bird populations. Such information has been systematically organised and used for scientific investigations as well.

Building Capacity of Students and Teachers

To take advantage of the enormous capacity of students and teachers in participating in organising an information base on India's environment, we need to build their capacity in many ways.

Data Collection Methodology

Students must follow sound methodologies in making and recording their observations. For this purpose, they need to properly pose the hypotheses that will guide data collection, and then record appropriate observations avoiding any bias as far as possible. However, it is also important that the exercises be so designed as to be practicable. To this end, we need to create a large bank of hypotheses and methodologies that will suggest the kinds of projects that may be taken up. Such a hypotheses/methodology bank could be made available through the NCERT website. The students and teachers should of course be free to come up with their own original projects, taking care that the hypotheses are well posed and the data collection methodology well designed. As an example, consider the following project:

Hypothesis

Fish/mollusk species diversity is significantly higher in waters with lower levels of nutrient contents. *Methodology:* Our objective is to compare the species richness of fish or mollusk (snails and bivalves) fauna in relation to the nutrient content of river water. Thus many rivers will have low nutrient levels in stretches closer to their origin, and much higher levels in stretches passing through plains and human settlements because of sewage discharge. One may select a total of 40 points for comparison. At each sampling point, record the lat-long with the help of a GPS instrument if possible. It would be desirable to document the nature of locality being investigated with the help of careful photography by digital camera. Throughout its entire extent river fish are caught by members of fishing communities. These should be contacted and with their help fish caught in any particular locality documented. If needed specimens may also be purchased from the fishermen. Alternatively, students themselves can undertake an all-out search

for mollusks for a fixed time period, for instance four students over 1 hour, or two students over 2 hours, etc. The fish/mollusk species should be documented in terms of their local names and careful photography by digital camera. Simultaneously water samples should be collected and analysed for COD, BOD, N and P content and opacity. The whole exercise may be best conducted in the immediate post-monsoon period over October-November.

Data Record Schedules

There will be three sets of Data Record Schedules, one for each species, one for each locality, and one for each mollusk/fish species versus locality.

Table I: Species-wise Data Record Schedules

Species	Scientific name	Local name	Dimensions of the largest individual encountered during the study	
			Body length	Weight
1				
2				
...				
12				

Table II: Locality-wise Data Record Schedules

Locality #	River	Lat	Long	Date of sampling	COD	BOD	Opacity	N	P
22									

Table III: Species x locality Data Record Schedules

Species #	Locality #	Abundance
12	22	33

For fish it might be feasible to only record presence/absence. For mollusks, numbers may be recorded.

Data Types

The data collected may range over a variety of types, including numbers (e.g., abundance), categorical (e.g., species names), text (e.g., descriptions of habitats), pictures and audio-visual clippings. It is now possible to handle all this kind of information as a part of a computerised database.

Structuring of Data

The simplest way of arranging such data in a structured fashion is in form of tables as depicted above. Computerised databases facilitate bringing together data from different tables as desired. For instance, table II gives the status of pollution at different localities, whereas table III gives the abundance of the species at different localities. We can look at the relationship of fish/mollusk abundance with the BOD level by juxtaposing table II and III. It is also possible to link unstructured data such as pictures with structured data and retrieve relevant clippings.

Data Aggregation

There are now available a number of tools for pooling together information from different sources, such as shared spreadsheets, documents and maps. A shared spreadsheet (or document or map) may be made available to all or selected users of the spreadsheet for concurrent data entry or modification, on a private or public network. Each authorised user is able to make modifications to the spreadsheet (or document or map), or simply view it, according to the level of authority assigned to them. One user may be able to modify any cell in the spreadsheet by changing its value, layout, position or formula whereas other users may be restricted to entering values into one or more cells. In a similar fashion users may simply view or modify the shared documents or maps. Significantly, all historical versions of the material remain available, so that any mischievous changes that may have been introduced can be eliminated.

One may visualise students from a particular school, or different schools in given region such as in Pune district, or watershed of Alakananda river collecting

information on BOD levels and other water quality parameters as a part of their Environmental Education projects. They may all be authorised to access a shared spreadsheet on which information from a number of different investigations can be uploaded, validated by a moderator, integrated, analysed and eventually shared with the public.

A Network of Websites

As a next step one may visualise individual schools, or consortia of schools in a given city or a distinct setting up "wiki" sites on a website where the information being generated from various student projects will be uploaded and be open to public scrutiny and validation. A wiki is a piece of server software that allows users to freely create and edit web page content using any web browser. Wiki supports hyperlinks and has simple text syntax for creating new pages and cross-links between internal pages on the fly. The expert support needed for such an endeavour of collaborative generation of knowledge on India's environment through student projects may be provided with the help of a Technical Support Consortium (TSC), preferably constituted at the level of each district. This group will have to help adapt manuals detailing study methodologies, and formats in which quantitative data may be collected, as also other resource material such as field guides to identification of bio-indicators of water quality to the local context. Most importantly, the TSC may help through assessing the quality of the primary data posted by students or other interested citizens on the various wiki sites that may be networked to constitute a non-peer-reviewed publication called "Status of district's environment or Zilla Parisara Sthiti". TSC may help in selecting material of good quality from this information resource, help in its interpretation in light of available scientific knowledge and in its publication in an appropriate peer-reviewed medium. Since much of such information, although of good quality, is likely to be of very locality-specific interest, it might be worthwhile organising a locality specific on-line publication called "State of district's environment or Zilla Parisara Prakashana" to host it. Once properly peer reviewed and published, this information may be used to write articles in other media such as Wikipedia or Encyclopaedia of Earth.

The currently active India Water Portal, or the proposed Environment Portal, as also the NCERT website may support these activities by promoting:

1. System of participatory software and mechanisms.
2. Software capability to accept contributions from student projects.
3. Process, policies and procedures for accepting, vetting and posting contributions from the student projects.
4. Agreed priority list for themes for organising a process of participatory monitoring of environmental parameters.