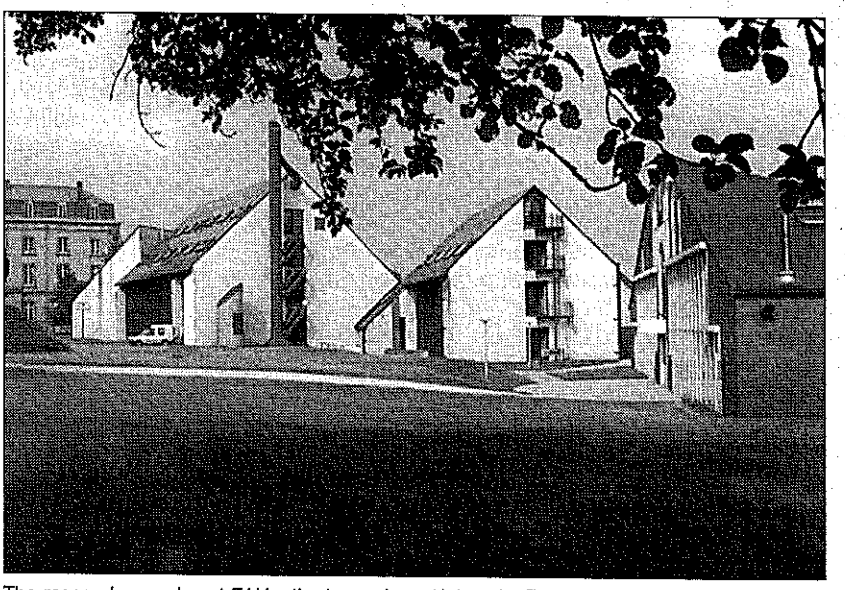
Environmental Monitoring at F.U.L

L.W. DE BACKER, Ph. ANDRE and J. NICOLAS

The Fondation Universitaire Luxembourgeoise (F.U.L) is a non-profit foundation with the aim of stimulating and coordinating applied research and postgraduate education in the field of Environmental Sciences and Management. To reach these goals, it works within a framework of close collaboration with not only the other French-speaking universities of Belgium and neighbouring countries such as Luxemburg, Germany and France, but also with decision makers in the public and private sectors at the regional, national, European and international levels.

The amount of research to be conducted in these fields is very large, and a selection has to be made. To make a long story short, the various postgraduate teaching curricula offered by F.U.L. reflect the two main components which should be integrated in environmental management : the natural resources and the human factors. The three research teams of F.U.L support these curricula with their experience and call on colleagues of other universities for subjects outside their own fields. They focus their research on Water, Energy and Land Use, the first two being fluxes of essential importance in the management of man's activities in a given territory. The sustainability of the development of human society is probably based on the renewable character of the quantity and the quality of these water and energy fluxes.



The research complex at F.U.L., the Luxemburg University Foundation.

Within this context, *Environmental Monitoring* was selected as the theme of one of the first postgraduate specialisations to be offered. The other specializations in which monitoring is always involved, are Public Management of Environment, Integrated Management of Water Resources, Water Management and Agrometeorology.

The research in Environmental Monitoring at F.U.L. is based on the fact that, for management purposes, it is becoming increasingly necessary to set up efficient systems for continuous control of the indicators reflecting the state of the environment. Both field data acquisition techniques and data treatment are tackled. Particular attention is given to " intelligent " measurement, bio-sensors and event forecast algorithms. The team of

researchers tries to integrate the three steps of monitoring : measurement, treatment and decision making support.

Research is conducted on four elements of the environment : climate and air, soil, water and buildings.

Short-term fog forecasting [1] implies for instance an indicator grouping data from optical counting, filter sampling and chemical analysis of air particles. Meteorological data acquisition with automatic storage in a monthly filing is available on PC diskette compatible with classical treatment softwares.

Water quality sensors such as a DBOMETER prototype using a pressure transducer have been successfully tested and two other biosensors for BOD and nitrates are under development using fixed biomass and enzyme respectively.

Soil water status and quality, such as water potential and electrical conductivity, depend on the manufacturing of the sensor ceramic. Reproducibility is expected soon with a more rigorous heating procedure.

Heat and water transfers in soils and aquifers have been observed in five field stations. The SOIL model is validated for 3 of them : Vance, Buzenol and Sterpenich. In Arlon, the model is not only validated but was used to simulate shallow depth heat extraction in a field experiment called SOLPAC. Nitrates dynamic is being simulated with a SOIL N model. In addition, the SOIL model can be regarded as an " intelligent measuring tool " for parameters which are hard to determine otherwise, such as Leaf Area Index, albedo, soil saturation depth, ...

Artificial intelligence techniques in support of decision making are first applied to energy management of a partially solar heated building in two complementary ways :

- The real-time control of building heating consists of assembling regulation algorithms, experience of the heating system manager, breakdown, trouble shooting, etc. into production rules of an expert system. A *"Heating expert"* software has been developed and tested on the F.U.L. buildings as described in the body of the article, and analysed in greater detail in [2]. It elaborates the following rules on strategic decisions, technical operations, general intervention due to environmental variables, breakdown, economics and " good sense ".
- The integration of computer tools in the environmental design of buildings is also based on a layered structure. The software is developed on PC in TURBO PASCAL using its object-language oriented possibilities. This integrated software is called « IDEFIX » *(Intelligence Decision making in Environmental Problems Featuring the Integration of Cross-resources).* Prototypes of drivers between various softwares (CAD, simulation, data bases, expert systems) are being developed. The central database and the drivers are integrated and completed with a user's layer based on the " IBDS " scheme elaborated in 1989 [3].

Finally, the research team on Environmental Monitoring collaborated on two International Energy Agency projects : IEA Task 11 « *Passive Solar Commercial Buildings* » and IEA Annex 21 « *Calculation of Energy and Environmental Performance of Buildings* ». Their objectives are to elaborate on directives based on experimental results for designers of buildings and for model users.

The chapter pertaining to the passive solar system " mass wall " for the IEA « *Source Book* » [4] has been completed and brochures published for the public [5]. A software package called " IDSOFT " has been developed for the identification of environmental dynamic systems where measurements occur. Furthermore, a methodology for the classification of thermal models in buildings has been presented.

Perspectives for the following years are to proceed with the three steps of monitoring : *measurement, data treatment* and *decision making support.* However, the accent will be less on learning the various techniques required to reach these goals than on making these techniques available to F.U.L.'s other two research teams, thereby aiming at integrated management of the environment.

Indeed, sustainable development requires more than one objective. Multicriteria analysis is thus a methodology appropriate to earn the satisfaction of the decision makers in presenting various scenarios. Also, environmental data is rather vague in nature and the " fuzzy numbers " theory appears to be an adequate tool to handle them in an extended expert system configuration.

References

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