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### **Methods for interdisciplinary research on problems in human ecology**

*Problems in human ecology are complex, interrelated, incommensurable and interdisciplinary. The often need to involve stakeholder approaches and show a plurality of values. Research strategies should deal with these characteristics and research methods reflect these characteristics.*

*The paper analyses these aspects in two ways. In the first part the results of the analysis of 15 research papers are discussed. The focus is on the methods that are used in these papers. It is shown that research in human ecology uses a mix of methods that stem from a broad group of scientific disciplines. The heterogeneous set of data that results from this array of approaches necessitates methods to integrate and structure these data.*

*The second part of the paper addresses in a synoptical way the results of the implementation of an environmental management system in 39 primary schools in South Africa. The results show how such an environmental education programme illustrates to characteristics of approaches to environmental problems.*

#### **Introduction**

Few problem addressing the reciprocal relations between humans and their environment can be solved using one method either chemical, psychological or economic. This is because of the characteristics of human ecological problems. They are

- Interrelated-complexity: interrelatedness refers to the situation that human ecological problems are complex. Most often one is not faced with one problem, but with a network of problems. Therefore simple approaches donot apply in human ecology.
- Incommensurable-incompatible: these terms refer to the fact that different scientific disciplines establish different points of view on an environmental problem. These different points of view might originate from fundamental differences. Timeframes in ecology range from short terms to transgenerational perspectives. Geographical scales in human ecology range from local to mundial. Values might range from selfish to most altruistic, or from targeted to the individual to community directed.
- (multi-) interdisciplinarity (trans-): problems in human ecology require insights from several scientific disciplines (multidisciplinarity). Moreover these multidisciplinary aspects need to be interconnected and integrated. This necessitates establishing a web of interrelations with the necessary feedbacks. This form is synthesis is called an interdisciplinary approach. When from this interdisciplinary approach now concepts, methods and results emerge, the transdisciplinary stage is reached.
- Stakeholders oriented: human ecological problems are closely linked with the people who live in the area where the problems occur. Therefore, the ideas and perceptions should be included in the research rationale. (Local) stakeholders have an expertise that is different from and complementary to this of the environmental consultant or the

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university professor. It is worthwhile to bring this specific knowledge on board of the human ecological research approach. Doing so, necessitates however specific methods.

- Value plurality: ethics is important in human ecology. Definitions of human ecology often refer to a background that is as a rule ecocentric. Many key issues, including global changes and biotechnology applications, necessitate ethical reflections.

Research strategies for complex environmental problems should take into account these characteristics and deal with them. This does not mean that each valid research strategy in human ecology should deal with each of these aspects, rather the research rationales should address these characteristics in relation to their importance in the problem that is investigated. In this paper two aspects of these strategies are discussed:

- The first part of the paper entails an analysis of 15 research papers in human ecology. It lists the methods that are used and aims to obtain a (selected and incomplete) overview of methods in human ecology.
- The second part describes the methods used in an interdisciplinary environmental education project that aims at introducing environmental management systems in schools. To this end the set up and the monitoring of green primary schools in the Central-Northern provinces of South Africa are discussed.

### **Research methods in human ecology**

#### **Materials and methods**

The book “Research in Human Ecology” (Hens et al., 1998) entails 15 chapters of original, peer reviewed research works in human ecology. The chapters are contributed by groups from 13 countries spread over 3 continents. Each of these 15 chapters was analysed by master degree students in human ecology. Each chapter was analysed three consecutive times in an independent way, by a different group of 3 students, to obtain consistency in the results. The students were asked to:

- Summarise the chapter
- Indicate which interdisciplinary concepts, basic scientific disciplines, research methods and applications were traced in the chapter they analysed.

Their findings were documented in a paper. The paper was discussed following a presentation in class.

The following section focuses on the results of the analysis of the research methods.

#### **Results**

Table 1 provides an overview of the results of 3 example chapters. The table shows which concepts, disciplines, methods and applications are encountered in chapters on:

- Environmentally targeted community research in Maine (US) (Borden, 1998)
- Traditional fishermen knowledge in Southern Brazil (Begossi, 1998)
- Environmental health problems among farmers near Toulouse (South-Western France) (Lefevre-Witier et al., 1994)

## ЧАСТИНА 2 НАУКОВІ ПОВІДОМЛЕННЯ

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The data of the table allow to evaluate the research issues in their context of content, concepts, disciplines and applications. It shows e.g. how field research on indigenous knowledge builds on the legacy of anthropology and contributes to a more soundly funded local management.

Table 2 combines the results when all methods over the 15 chapters are taken together and structured. The table shows that 4 groups of methods are recognised:

- Methods that root in the sciences: laboratory methods as used in biology, chemistry or physics are prevailing. Also fieldwork that combines biological approaches with chemical, geological and sociological analysis is common.
- Methods that root in applied sciences: In the 15 chapters that are selected medical research methods prevail. Both clinical (laboratory analysis) and epidemiological methods are applied. It is rather coincidental that no methods that are common in engineering sciences appear in the list. Other researches integrate indeed methods from hydrology, technical mobility studies or waste treatment.
- Methods that root in the human sciences: in this section questionnaires and group discussions prevail. An other selection of papers might have revealed also research methods that are used in psychology, philosophy or in law and criminality studies. To this group belong also the methods applied in education studies.
- The last group concerns methods targeted towards integration of data. In the chapters under study geographical information systems (GIS) and data mining techniques prevail. Also modelling methods belong to this group.

### Discussion

Over all, the results show that nothing exists as a method that is always and only applied by human ecological researches. They make use of the research methods any scientist uses. Literature searches and general scientific paradigms in a first instance. Apart from these general aspects, the specificity of research methods in human ecology appears along two main axes:

- They span a very wide field of methods that apply to the humanities, basic and applied sciences. Rather than the sum of these individual approaches, it is the selection from and the combination of these methods that provides each research project with a specific basket of problem tailored materials and methods.
- The interdisciplinary nature of the problems results in inputs from many disciplines and results in heterogenic data sets. The same research can provide descriptive qualitative, semi-quantitative and quantitative data. Therefore human ecologists are keen on



## ЧАСТИНА 2 НАУКОВІ ПОВІДОМЛЕННЯ

methods that allow to combine, relate and integrate heterogeneous masses of facts and figures. Geographic information systems (GIS) that allow spatial representation of data and a wide range of statistical treatments, are increasingly used in human ecological studies. So is data mining, one of the methods that allow to structure at first glance, hardly related data.

1	Methods rooting in science - Labwork - Fieldwork
2	Methods in rooting in applied sciences - Epidemiology - Clinical methods
3	Methods rooting in human sciences - Questionnaires - Group discussions
4	Integration methods - Geographical information systems (GIS) - Data mining

Table 2: Research methods applied in original human ecology research papers

### **Introducing and monitoring environmental management systems in schools**

#### **Background**

Environmental management systems (EMS) originate from industry. They are a typical example of a continuous improvement on environmental performance strategy. They are an example of how common management approaches offer a systematic strategy to tackle environmental problems in industry. Often they are applied to help industrial plants to comply with the law, but they can continuously improve the performance of an industrial organisations. Environmental management systems that operate according to defined international standards, can be ISO 14001 certified.

Environmental management systems are not limited to industrial plants. Any organisation, whether an hospital, an administration building, a hotel or a school, uses resources and produces pollution. Limiting the (environmental) resource consumption and the pollution are the main targets of an environmental management system. Moreover, using EMS at schools allows also to confront the teachers, pupils and other stakeholders with managerial theory, concepts and skills. In addition there is growing evidence that participation of pupils in EMS also develops more general societal skills that are most useful in their future professional and family life. This context allows to define an EMS in a school as “a systematic, coherent set of measures and provisions intended to quantify, prevent and where possible, limit the amount of pollution generated by the school” (Van Volsem and Vens., 1997).

EMS for schools use a wide array of methods both in the implementation of the system and the monitoring of the results. Therefore they are a useful example of the interdisciplinary nature of how to address complex environmental problems in an educational context.

Moreover, the monitoring of these schools show how heterogeneous data can be combined in a holistic context to answer specific questions on the environmental and managerial performance of an EMS.

## Materials and methods

### *Geographical locations*

The data discussed in this paper relate to 39 primary schools in the Northern-Central provinces of South Africa: Northern Gautheng and the Southern part of Limpopo. Of the 39 schools in total, 7 were classified as urban schools, 19 as rural schools and 13 as township schools.

#### - *Introduction to the EMS*

To explain how schools can introduce an environmental management system, teachers and other stakeholders (principals, teachers, representatives of the administration and parents) were invited to assist in a capacity building workshop.

During the workshop the sequence of the managerial steps to be taken was explained and commented upon. As shown in figure 1 the main steps entail a decision on the main environmental problems in the school, a policy declaration that phrases in general terms the vision of the school on environmental management, the establishment of an action plan to realise measurable targets, the implementation and monitoring of the plan, the accompanying communication to all target groups, and the evaluation of this management cycle. During the following year a new subject can be addressed using the same management method.

The schools were offered to work on 4 possible subjects of environmental care as they appear in the direct vicinity of the school:

- Water with a focus on water consumption and water pollution,
- Waste during which possibilities to prevent and recycle waste are addressed. The inconveniences and threats by refuse waste are dealt with,
- Energy focuses on electricity consumption in the schools and options to use sustainable energy at a local scale,
- Greening pairs attention to the school garden of which the vegetables benefit the pupils and the local community.

Both the managerial and the environmental aspects of the system are described in detail in a guideline book that was discussed with and provided to the teachers (Raath et al., 2004). The guideline book was complemented with a toolkit that contains the materials for 10 experiments that allow to illustrate the 4 environmental areas that are offered to the schools.

#### - *Implementation and monitoring*

The schools implement the stepwise procedure class by class. They appoint an environmental coordinator who leads the process and an environmental committee with representatives of the stakeholders.

## ЧАСТИНА 2 НАУКОВІ ПОВІДОМЛЕННЯ

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The progress the schools make in using the EMS is monitored and quantified, using a standardized questionnaire. This questionnaire is completed 3 times during a two year period: before the EMS starts, a baseline survey ( $T_0$ ) is carried out; this is followed by a first survey after the first management cycle is completed ( $T_1$ ); and by a second survey, one year later, after the second management cycle is completed ( $T_2$ ). After completion of the questionnaire related to the second management cycle, the schools were visited by an independent researcher who performed a “ground truth” check. This procedure allowed to fill gaps in the data base and to verify outlying values.

The checklists entail 72 questions. Each question is either related to the managerial aspects, the pedagogical aspects, the attitudes and societal aspects and the environmental aspects (water, waste, energy, greening) of the EMS use. Scores ranging from 0 (doesnot apply) to 4 (full applies) are allocated to each question.

### - *Statistics*

The results of the surveys are introduced in a relational database. Average results are calculated by school and the results are presented by parameter in histograms. To analyze whether an improvement of the managerial aspects is correlated with an improvement of the environment performance. Pearson correlations between the average results of the management aspects and average values related to the aspects of environmental performance, have been calculated.

## Results

The full results of this two years study have been published elsewhere (Hens et al., 2009 a, b). In this paper only selected results are included to illustrate the type of questions that are addressed and to show the interdisciplinary research nature of environmental education projects.

Figure 1 shows the overall data for water related actions. For each of the school types (urban, rural, township) the evolution of their engagement in water related activities over a period of two years is shown. Water related activities in this EMS entail controlling leaking taps and toilets, re-use of rainwater and the equipment of toilets with water saving technologies.

The figure shows that the participation of the schools on water initiatives improved during the two years the monitoring lasted. At the beginning of the monitoring period ( $T_0$ ), 90% of the urban schools, but only 30% of the township schools and 45% of the rural schools acted to save water. Two years later 70% of the rural and township schools and 100% of the urban schools act on water issues.

A more detailed analysis of the results (Hens, 2009a) shows that schools are acting primarily on water saving in toilets, and less e.g. on collecting rainwater (mainly as the result of a lack in limited investments in water tanks and related infrastructure).

To find out whether appropriate managerial approaches affect the environmental performance, Pearson correlation coefficients were calculated between the average scores for managerial

**ЧАСТИНА 2 НАУКОВІ ПОВІДОМЛЕННЯ**

aspects and the average scores for environmental performance. For the latter aspect correlations were calculated for water, waste, energy and greening separately. Table 3 shows the significance levels resulting from these calculations. The table shows that

- For most of the possible relations no significant correlations are found. This is not surprising for the baseline data (as no EMS was implemented), but is more surprising for energy and waste where only 1 significant correlation coefficient could be detected. The result probably reflects the latency time that is needed to make an EMS effective
- For the first survey results strong correlations are found between managerial averages and both water and greening
- For the second survey water and waste are strongly correlated with the scores for managerial aspects.

<i>All schools</i>	<i>Water</i>	<i>Waste</i>	<i>Energy</i>	<i>Greening</i>
Baseline survey	0	0	0	0
1 <sup>st</sup> survey	++	+	0	++
2 <sup>nd</sup> survey	++	++	0	+
<b><i>Township</i></b>				
Baseline survey	0	0	0	0
1 <sup>st</sup> survey	++	0	0	++
2 <sup>nd</sup> survey	0	0	++	0
<b><i>Rural</i></b>				
Baseline survey	0	0	0	0
1 <sup>st</sup> survey	0	0	0	0
2 <sup>nd</sup> survey	++	0	0	++
<b><i>Urban</i></b>				
Baseline survey	0	0	0	0
1 <sup>st</sup> survey	0	0	0	0
2 <sup>nd</sup> survey	0	0	0	0

Table 3: Significance levels of Pearson correlations between the average scores for managerial aspects and the average scores for environmental performance (water, waste, energy and greening) in primary schools in South Africa.

- The table shows that in all schools, independent from their type, the following correlations are detected:
- At the 1st survey: water and greening are strongly correlated with the scores for managerial aspects.
  - At the 2nd survey: water and waste are strongly correlated with the scores for managerial aspects.

The shift from strong correlations with greening in the first survey to waste in the 2<sup>nd</sup> survey, shows that in most schools the parameters for greening improved fast during the first year and consequently could hardly improve more during the 2<sup>nd</sup> year. On selected water (collection of rainwater) and waste (sorting the school waste) more improvement was possible and made, resulting in significant correlation coefficients during year 2.



Discussion

The most strict interpretation of these data is that complex but hierarchically and appropriately designed approaches to environmental management systems in schools, improve their environmental performance. As shown in figure 1, this is the case for water related actions, but this can also be convincingly shown for waste actions (Hens et al., 2009a). Guidance of the schools in implementing environmental actions works, in particular when it comes to environmental results.

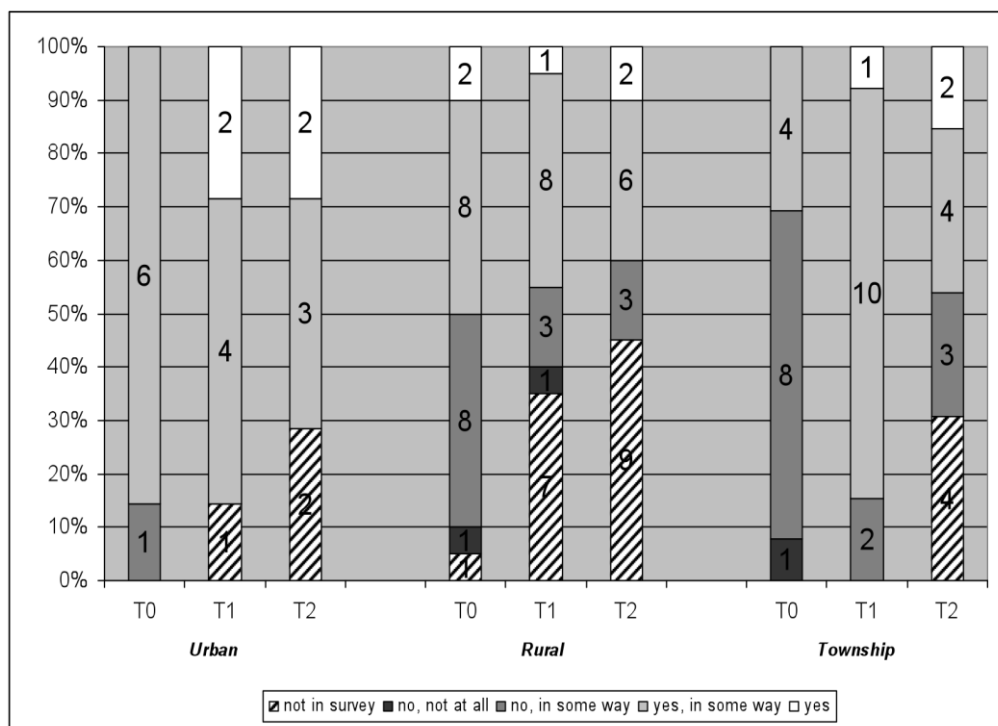


Figure 1: Average scores of participation by school type for actions on water in 39 primary schools in South Africa

The correlations between managerial aspects and environmental performance (Table 3) reflect that schools with a motivated environmental team perform well on all proposed aspects of the EMS. Inversely, these correlations show that a well elaborated organisational implementation of the EMS is a necessity if a school aims to perform well on environmental care.

From the wider perspective of research methods the example shows that also in environmental education issues it is possible to bring the message of the fundamental characteristics of the complex environmental problems where humans are involved in across. A few examples:

- Problems are interrelated: very often in a dirty environment not only (refuge) waste is abundant, but this is as a rule linked to poor water quality. Saving energy and limiting

the water consumption are driven by the same fundamental concern of wise use of resources.

- Environmental problems require interdisciplinary approach: in EMS managerial aspects and skills are intimately linked with environmental performance. The environmental aspects relate to biology, physics, chemistry, mathematics, languages and arts. They can be built in, in a transversal way in the curriculum of the schools.
- Environmental problems require stakeholder oriented approaches. The implementation of an EMS needs the leadership of an environmental coordinator but can only be successful when it is properly communicated to and can point on the collaboration of the stakeholders. This stakeholder involvement is materialised in the environmental committee where all stakeholders are represented and which guides the implementation of and the decision making on the EMS.
- Finally, the issues addressed in the EMS provide ample opportunities to link environmental issues with value driven choices. Why should we attempt a saving attitude towards environmental resources? What are the ethical aspects of limiting pollution? An EMS allows in a logical way to link environmental issues with ethical options.

Overall the EMS approach to environmental education allows to face the students in a pragmatic and practical, less theoretical way, how environmental issues can be handled. The approach has an important content and research basis.

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**Використання методів міждисциплінарних досліджень  
для вирішення проблем екології людини**

*У статті розглядаються проблеми екології людини як комплексне, міждисциплінарне й взаємопов'язане явище. Методи дослідження екології людини повинні включати безліч зацікавлених кіл суспільства, а також, використовувати багатокритеріальні цінності. У роботі проблеми вивчення екології людини розглядаються із двох сторін. По-перше, значна увага приділяється методам дослідження екології людини, і підкреслюється, що в даному науковому напрямі використовуються методи інших наукових шкіл та дисциплін. По-друге, у роботі за допомогою багатокритеріальних методів екології людини, розглядається програма впровадження системи екологічного менеджменту в початкових школах Південної Африки. Для дослідження було вибрано 39 шкіл в північних та центральних провінціях Південно-Африканської Республіки (ПАР), зокрема досліджувалися північна частина Гаутенгу і східна частина Лімпопо. З цих 39 шкіл 7 було класифіковано як міські, 19 – сільські, і 13 – школи в селищах міського типу.*

*Результати дослідження показують наскільки програма екологічної освіти ефективна в вирішенні екологічних проблем.*

## ЧАСТИНА 2 НАУКОВІ ПОВІДОМЛЕННЯ

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*В кожній з 39 було запропоновано такі природоохоронні напрями:*

- збереження води, з фокусуванням на споживанні і забрудненні;
- поводження в твердими побутовими відходами (ресайклінг);
- проблеми енергетичного характеру;
- озеленення територій.

*Освітні програми по збереженні води проводилися протягом двох років. На початкових етапах проведення програми в усіх освітніх закладах було проведено попереднє оцінювання стану використання води і було встановлено, що в 90% міських шкіл і лише 30% сільських та 45% селищах міського типу, впроваджували заходи по раціональному використанню та збереженні води. Через два роки, після проведення освітніх програм, 70% сільських та селищних шкіл запровадили заходи по більш ефективному використанню води, для міських шкіл даний показник склав 100%. Покращання ефективності використання води виражалося в відсутності непрацюючих кранів, через які текла б вода, використання дощової води, більш якісне водозберігаюче обладнання в шкільних закладах. Зокрема для сільських шкіл значний прогрес після дворічної освітньої програми полягав в тому, що з'явилося більш ефективне водозберігаюче обладнання, в той же час як збільшення об'ємів збирання дощової води в баки майже не спостерігалося.*

*Одним із важливих результатів дослідження є те, що при проведенні окремих програм з водозбереження автоматично підвищувались досягнення в інших напрямках: озеленення, енергозбереження.*

*Підготував:*

***О. Кубатко***