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in

Camarda D. (ed.), Grassini L. (ed.).
Interdependency between agriculture and urbanization: Conflicts on sustainable use of soil and water

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 44

2001
pages 379-389

ENVIRONMENTAL INDICATORS FOR THE SUSTAINABLE USE OF SOIL AND WATER: SOME NOTES ON A HYBRID AND PARTICIPATORY PERSPECTIVE

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Introduction

The challenge for global community in the planet represented by massive human activities and urban processes and the related environment consumption and decay is increasingly recognized.

In this complex cognitive and operational domain, a need for environmental analysis based on quali-quantitative indicators and formal and informal modelling is also increasingly recognized.

In particular where socio-economic organizations and public and private institutions and policies do not provide planning communities with both reliable data bases and formal staffing to face environmental monitoring and control, there is the need of integrating formal and informal knowledge modelling in planning operations.

Problem setting, knowledge structuring and scenario analysis in modelling environmental dynamics, in the frame of a participatory action research dealing with soil erosion and water contamination in peri-urban rural areas in the Southern Mediterranean rim (Morocco, Tunisia), are at the core of this EU-founded C.A in it, evaluation and modelling methods managing both formal-expert and informal-non-expert knowledge base and reasoning – with a particular attention to the role problem for planners and stakeholders in plan-making – are explored in a theory-in-practice and self-sustainable perspective, with the final aim to provide reliable environmental information for global and local policy-making.

The present paper aims at contributing in the direction of environmental analysis and knowledge enhancement put down by the Concerted Action, by dealing with the state of the art of quali-quantitative indicators.

Evolutionary background

Historically, the search for manageable indicators has been devoted to partial or limited scope, mainly regarding the aspects of economic growth and development

(such as analyzing economic trends, or comparing economic performances in different regions, etc). We can remember, for example, that the diffusion of the *Leontief's input*-output matrix (Leontief 1953) is linked to the first successful attempt to obtain a structured multi-dimensional indicator for economic growth. The same method has been lately amended in the attempt to address social issues by the work of Hirschman (1958). As a matter of fact, one of the limits of the economic deterministic approach to indicators is the difficulty of including social and environmental factors – often qualitative and incommensurable, but increasingly important in today's public management. In particular, after the awareness of the concept of sustainable development boosted by the Brundtland Commission in 1987 and followed by the punctual indications of Agenda 21, sustainability has become a crucial issue to be addressed, monitored and promoted in development policies and decision-making processes[1].

Generally, after a first freelance approach to the problem, the search for effective indicators for sustainable development has been increasingly supported by International Organizations and Institutions, often within permanent inter-organizational Commissions and Conferences[2]. The work of these international sessions highlighted some core issues and problems of dealing with indicators, causing a progressive abandonment of the deterministic illusion in favour of a holistic but also more shared approach. For example, traditionally diffused compact 'super indices', easy to be measured, compared and managed, and easily understandable by normal people are claimed less strongly than previously, and with a more critical approach. Scholars are now aware of the loss in significance caused by oversimplification, and of the discrepancy between highly aggregated indices used by policymakers at the national level and indices used by local communities for which other kinds of indices may be relevant, so suggesting hybrid, semi-aggregated indicators operating at both levels (Sawicki and Flynn 1996). Oversimplification is a danger mainly stemming from globalization-related issues extremizing the concept of

[1] For example, FAO participated in an initiative to develop indicators for each chapter of Agenda 21, developing more than 40 methodology sheets on how to calculate indicators in the areas of agriculture, biological diversity, desertification, fisheries, forestry, freshwater, land use, and mountain ecosystems in Africa, Asia and Latin America. Some Countries in those regions are now testing the indicators for practicality (Tschirley 1998).

[2] This is the case, for example, of the so-called Bellagio Forum for Sustainable Development, a partnership between foundations in different parts of the world, whose major priority is to develop a small number of highly aggregated indicators for use at national level, as way a to measure and assess progress toward sustainable development (Bettelli and Pinter, 1999). Other examples range from the UN-based Conference to Combat Desertification, which is increasingly underscoring and refining benchmarks and indicators that can be used to compare sustainability in different Countries, to the Consultative Group on Sustainable Development Indicators, whose major work is to promote cooperation, better coordination and strategy among key individuals and institutions that work on developing and using sustainable development indicators (Churie et al., 1999).

comparability to all worldwide contexts, so often loosing details on endogenous aspects inside each Country.

Indicators and environmental planning

In this context, environmental planning is being involved directly in the debate about meaningful and manageable indicators, especially because of the increasing awareness of the positive role of public participation and social learning for effective planning (Innes 1975, Friedmann 1993, 290-291). In the effort to analyze local patrimony, identify natural resources and plan for their future use, planners and policymakers face new forms of knowledge, expert in substantive terms rather than technical terms. The interaction with this new knowledge is aimed at (mutual) comprehension but also at building consensus on plans and policies, and the terrain on which to interact is crucially left to formal/informal indicators to agree upon (Innes 1990). This upcoming approach has taken place rather recently, and under the impulse of contingent interests, the recent history of partecipated indicators for environmental policies and plans can be said as mainly channelled into a bunch of mainstreams, possibly and roughly identifiable as follows. Firstly, we can find the macro-level, planetary ambit, whose debates are focused on the consequences on the whole world systems by cumulative local forms of pollution and aggression to nature: typical cases are for example greenhouse effect and ozone layer depletion (Depledge et al.1999, Eurostat 1999). The second ambit is the city, or urban agglomerations, with problems of pollution, congestion and decrease of life quality: this is considered as the traditional context for planning activities, and the use of environmental indicators largely takes place, for policy and planning purposes (Haughton and Hunter 1994, Bertuglia et al. 1994, Maclaren 1996). Thirdly, we can find non-urban spaces, i.e. rural areas, forests, landscapes and the natural environment as a whole: it is another important field for environmental planning, in which the use of environmental indicators is widespread, particularly in such issues as desertification and deforestation (Churie et al. 1999, Ivers et al. 2000).

However, these polarized interests do not properly address the manifold urban and peri-urban problems induced especially in Countries affected by the massive urbanization of few cities, such as Delhi, Bejing, or Tunis, Cairo, Rabat and other urban agglomerations of Northern Africa. Following the dream of finding new opportunities, poor people living in rural areas migrate to cities and crowd urban fringes with irregular housing, often unsafe, unhealthy and always hard to be controlled and infrastructured (Banerjee 1996, 223). Furthermore, the majority of these regions historically found their economy on agriculture, and partially on trade: the unruled sprawl of suburbs takes away available precious soil from agricultural development, so subtracting long term value from soil, and negatively affecting the basic economical structure (Birley and Lock 1998). Finally, this massive process of

urbanization and rural outmigration causes agricultural activity to decrease in the countryside, so inducing a reduction in the economic performance of the countryside itself, traditionally dependent on agriculture (FAO 1999, 21). Therefore, urban and peri-urban contexts of developing regions like Northern Africa show peculiar and very important issues, increasingly involving the need for effective indicators for the evaluation of environmental transformations. But despite this importance, it is still difficult, today, to find consolidated literature on problems of interaction between urbanization and agriculture, and of sustainable use of resources in urban and peri-urban ambits, with regard to Northern African Countries. Furthermore, peri-urban ambits cannot rely on ready-made databases and research, given the early level of elaboration of its issues: the quest for effective indicators of sustainable use of soil and water (susw), need to explore neighbouring research, literature and databases of related fields.

In this concern, the problem which is most studied and addressed is land desertification, which is linked to different causes depending on economic, agricultural, trade, social and environmental factors. It can give important suggestions in the quest for indicators focused on the rural/urban interaction in Northern Africa, also because it is also a noxious effect of the massive process of land abandonment and urbanization by agricultural manpower. The following section will therefore deal with the insights offered by the studies on indicators for desertification, just because they are the most interestingly related to the sustainable use of soil and water in the context we are examining.

Unfortunately, as said, the research on desertification do not greatly focus on urban or peri-urban contexts, and so related indicators, even dealing with problems of sustainable use of soil and water, would need to be integrated by other indicators particularly highlighting both soil erosion and urban or peri-urban conflicts on the use of soil and water. For example, with regard to the problems of soil erosion, we could make reference to researches on indicators for land deforestation, which is however referable not to Northern Africa, but to other developing regions (Central Africa, Latin America, etc.) (Table 1). Another issue, i.e. urban environmental quality with related indicators, is diffusely dealt with in European/NorthAmerican studies and researches: such social- and environmental-related indicators would also need to be taken into consideration, being careful in using approaches that fit to the different context (Table 2). A further important source of information is urban/peri-urban agriculture, an activity peculiar and well diffused in Northern Africa, whose indicators can give interesting suggestions on the use of soil and water.

Tab. 1. Deforestation indicators (UNEP, 1998)

Pressure	State	Impact/Effect	Response
Production of Charcoal per capita (mc)	Relationship between Wood Reserves and Production (%)	Livestock Carryng Capacity Index (UA/ha)	Forest Action Plans
Annual Wood Production (m^3)	Surface of Forests (ha)	Wood Deficient Areas	Reforestation (ha)
Annual Deforestation (ha)	Surface of Savannas (ha)	Fragmentation of Forests ($4km^2$)	Relation Ref./Def.
Amazonian Deforestation	Rate of Increment of Planted Pastures (%)		Projections of Deforestation (ha/year)
Frontier Forests Under Threat			
Livestock Population (#)			

Tab. 2. Urban Environmental Indicators (UNEP, 1998)

Number	Type
1	Energy consumption
2	Non-recycled municipal waste
3	Non-treated wastewater
4	Share of private car transport
5	People endangered by noise emissions
6	Land use (change from natural to built-up area)
7	Inhabitants per green area
8	Water consumption per capita
9	Emissions of sulphur dioxide (SO2) & nitrogen oxides (NOx)
10	Derelict areas

Current approaches and new insights

Although some amendment to be done, studies on desertification offer a good overall perspective on new approaches. The problem of desertification is an important starting point for a critical discussion on indicators focused on Northern Africa, since several stimulating studies have been carried out after the formal recognition of the widespread occurrence of the problem, in 1977 at the United Nations Conference on Desertification (UNCOD). A milestone example was a project carried out by the Government of Kenya, that used a combination of remote sensing techniques and field surveys to collect data on selected desertification indicators proposed by FAO/UNEP (Table 3). Subsequently, it used a GIS to develop generalized models for application at regional and national levels, including separate models for water erosion, wind erosion, range carrying capacity, vegetation degradation, and human population (Ottichilo et al., 1990).

In the FAO/UNEP project it can be noticed that all of the chosen indicators are scientific and externally generated for local or national use: locally generated indicators are not considered, nor is the possibility of involving local people in the collection of scientific data. Traditionally, conventional measures and standards associated with the planning, monitoring, and evaluation of research and development projects have tended to be dominated by a "top-down" approach to data collection and analysis (Sawicki and Flynn, 1996). However, especially two issues are increasingly suggesting alternative indicators and approaches: diminishing the excessive costs of collecting several data, and involving people in the monitoring and evaluation process. These two issues, together with the increasing lack of significance of externally generated indicators have driven the attention away from a massive dependence on ‘top down’ scientific indicators. So research is now discovering "grassroots indicators", i.e. quali-quantitative signs of environmental quality or change formulated by individuals, households and communities, and derived from their local systems of observation, practice and indigenous knowledge. Through these indicators, local people can collaborate with decision makers to open up the rigid "top-down" sectoral approach typically used to delineate environment and development indicators (Hambly, 1996).

Advantages of the viability and convenience of this new approach can be better shown by another project carried out in Kenya, just using grassroots indicators as proxies, found with the help of local people, to monitor some environmental issues (Table 4). As can be seen, such indicators are rather informal, and difficult to be conceived, unless local people suggest and validate them: nonetheless they are completely, freely and easily available and monitorable. This circumstance is very important especially for those contexts – like developing Countries – where the difficulty in finding effective environmental indicators is mainly due to low financial resources for subsequent data collecting and monitoring.

Tab. 3. Desertification assessment factors (Ottichilo et al., 1990).

Type and subtype of indicator		**Factors**
Physical	Climatic	a.Rainfall b.Temperature c.Wind speed, direction and frequency d.Rain erosion potential (calculated) e.Sunlight duration f. Potential evapotranspiration — PET (calculated) g. Sandstorm/dust storm h. Vortices
	Soils	a. Surface status (rockiness) b. Texture c. Fertility (organic matter) d. Structure e. Permeability f. Erosion potential (calculated) g. Alkalinization/Salinization h. Soil unit map
	Topography	a. Slope
Biological	Vegetation	a. Canopy cover of herbaceous and woody plants (%) b. Aboveground biomass production (standing crops) of herbaceous/woody cover (kg/ha/yr) c. Plant composition and desirable or key species d. Potential herbaceous production (calculated) e. Vegetation unit map
	Animals	a. Animal population estimates and distribution b. Herd composition c. Herbaceous consumption (calculated)
Socio- Economic	Land and water use	a. Land use b. Fuel wood consumption c. Water availability and requirements
	Settlement patterns	a. Settlements b. Infrastructure
	Human biological parameters	a. Population structure and growth rate b. Measures of nutritional status c. Feeding habits
	Social process parameters	a. Conflicts b. Migration c. Transhumance d. Environmental perception

Tab. 4. Classfication of indicators (Krugmann 1996).

General	Specific	Examples
Ecolog. Indicat.	Reduction in, or disappearance of, particular tree species	Olmokatan tree — The bark is used as a catalyst for local brewing, as a traditional medicine for stomach problems (wormicide) "to clean the system", and as an appetizer. Olorien tree — The trunk is used to make charcoal pieces to clean calabashes (rubbing of inside surface). Charcoal residues also serve to preserve milk. Oiti tree — A hard wood to make sticks for walking and building purposes. Orkonil tree — The roots are used by the Maasai in soup and tea making, as an appetizer, and a kidney cleaner. Oliloriti tree — The bark is boiled to make a beverage (milk and sugar added), the hardwood is used for sticks, etc; and, it is also used as an herbal medicine against stomach problems. Osokonoi tree — The bark is used as a medicine to cure stomach problems, also for chest pain and sore throat (tonsils).
	Reduction or disappearance of (nutritious) grass species	Entimonyoa grass Erikaru grass
	Flowering of tree a few days before the rains come	Oiti tree Olmokotan tree
	Tree leaves change colour just before the rains arrive	Leaves of Olmomonyi tree turn dark
	Appearance spreading of gullies	
	Formation of "wicked winds"	Visible vertical vortices or small tornadoes through the sucking up of dust
Climatic indicat.	Cloud formations indicate impending rains	
	Elders look at stars to predict rains	
	Reduction in average rainfall	
	Variability in rainfall	
	Variability in beginning or end of rainy season	
	Prolonged absence of rainfall (drought)	
Land use indicat.	Elephants "harvest" maize	
	No water for livestock downstream from irrigation schemes	
Econom. Indicat.	Price indicators: relative prices in marketing chain (e.g., farmgate vs. wholesale)	Local prices of crops, livestock; terms of trade between the two or between rural and urban dwellers; prices of water, charcoal.
	Income indicators (difficult?)	
	Wealth and asset indicators: e.g. cattle holdings per family	
	Time or money spent by families on fetching firewood and water	
	Indicators of economic diversification	Number of people practicing agriculture or livestock management.
	Where are profits (re) invested?	
	Government support and extension services	

%

General	Specific	Examples
Social indicat.	Number of families per homestead (residential unit)	
	Inequality indicators (distribution of income and assets per family)	
	Number of wives per family	
	Form of bride wealth (cows, money)	
	What proportion of children go to school?	Proportion of children that looks after cows.
	Livestock transfers and associateships	Who bears the risks — giver or receiver?
	Changing gender roles	
Institut. Indicat.	Resource tenure indicators: landlord-to-tenant ratio	Status of land subdivision Access to water
	Existence of cooperatives or local interest groups	
Cultural indicat.	Proportion of Maasai who cultivate	
	Maasai going to the butcher to buy meat	
	Who selects wives?	
	Changing proportion of ethnic groups in the area	
Political indicat.	Local power relationships	
	Local effects of multiparty politics (e.g., land sub-division necessary for political reasons)	

Admittedly, the stable involvement of local people in partecipatory actions is historically not easy in developing Countries, and this should warn from an exclusive relying on grassroots indicators for monitoring and fighting crucial environmental problems. Therefore, an increasing tendency is to rely on both local and scientific knowledge, and bring the two together, calling for the local application of indicators that are generated either locally (i.e., grassroots indicators) or externally (likely scientific indicators) (Krugmann, 1996).

This combination of the two, usually called "hybrid indicators", may be a viable way ahead in the quest for effective, manageable and less expensive indicators, especially in developing Countries.

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