13 An instrument for environmental planning: The Land Use Resource Matrix

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13.1 Introduction

This chapter presents the results of theoretical and practical research aimed at developing an appropriate method for evaluating the environmental impacts of human activities, in the context of land planning processes[2].

Founded on some basic postulates[3] concerning the role in planning of evaluating the implications of environmental policies, an appropriate methodology consists in using instruments of analysis and evaluation, which are identified as: a land use resources matrix (LURM); the identification of the appropriate territorial unit of evaluation; and the definition of indicators and parameters of loading capacity for the various territories.

This chapter illustrates these instruments, in particular the land-use matrix, and their use in evaluation and planning processes. In fact the availability and use of such instruments seem essential requisites for correct planning, and as a means to avoid possible and dangerous errors in decision making.

13.2 Why a Land Use Matrix?

The method of land use evaluation presented here can provide a more reliable and co-ordinated level of environmental impact evaluation, linked to a system of expressed or simulated national parameters. This method consists of the construction and application of a *Land Use Resources Matrix* (LURM) on the basis of which available land resources can be determined. The purpose is to

estimate the availability or supply, and social demand for physical resources; to evaluate the overall social costs and benefits of this consumption.

After a brief examination of the nature and characteristics of the LURM, we will look at possible applications, including to the evaluation of programs and projects.

13.3 Nature and characteristics of the Land-Use Resources Matrix

The LURM is not different, in its basic purpose, from other matrices that have been proposed for analysis and evaluation of socio-economic projects with regard to their environmental impact[4]. A twofold vector is employed in looking at a territory: as the availability of a resource, having a multiplicity of original qualifications; as an object of human use, according to a taxonomy of use that is appropriate for the purposes of planning.

That is, we view the territory as a resource supply and as a resource demand. This particular way of constructing a Land Matrix, deserves some justification.

Environmental problems come about from an imbalance between demand for environmental resources, and their consumption, and the supply of the these resources, which is limited. The task of planning is complicated by the fact that the supply of environmental resources cannot be reproduced, and represent absolute, not relative, constraints on places, times, cultures, productive capacity, etc.

In the urban environment, environmental imbalance in the form of pollution, traffic congestion, the marring of the urban landscape, or the loss of social communication, is between the demand for the use by urban activities and the supply of environmental resources.

Thus the first analytical procedure required is that of listing land use demands and land resources. Land-use demands are based on activity needs and are classified by type of activity which needs to be accommodated, including housing, squares, roads, industrial activity, public spaces and buildings, green areas and recreational facilities, shopping, and so on. Available land resources are classified according to the intrinsic qualities of the territory and its vocations of use, both from the natural point of view and from the point of view of human activity, for example historic buildings, the urban landscape, green conservation areas, land for agriculture, areas for public infrastructure, and so on.

These two lists may face each other as on a scales[5]. But they may also constitute the vectors of a land use and resources matrix (LURM[6]), whose coefficients represent the transferral of existing resources into potential

demand; or, vice-versa, the transferral of the existing or policy-oriented demand into necessary resources in the form of spaces.

The construction of a LURM is not easy but is important to sound ecological planning of the city and region. Problems arise when the same land supply unit may at the same time satisfy several demands, and be in demand for several uses. We have classified such competitive uses as proper or improper[7], if they are considered compatible or not among themselves, by nature or extent. By nature, when a use damages another in quality (e.g. a steel works in the same block as a concert hall, to use an extreme example). By extent, when a use while not incompatible with another, as for example commercial activities with housing, becomes so because of the over-crowding it creates.

The LURM constitutes an analysis and evaluation model of the compatibility's and incompatibilities not only between alternative uses for a single unit of an available resource with existing or potentially available resources. The LURM, in short, constitutes an instrument for evaluating the opportunity cost of the use of a resource, in terms of the advantage lost for alternative uses. It provides a means of presenting decision makers with trade-offs between costs and benefits for reaching justifiable planning decisions.

The lay out of the matrix hinges therefore on the confrontation and resulting impact of these two conceptual entities: the supply of and the demand for limited space[8]. This format is common to all planning, which is concerned with balancing the impact of objectives and programs of action (demand), with the means, instruments and resources available[9].

The LURM method places the data on available or supplies territory on one side, and data relative to the territory requested or 'demanded' for existing and anticipated activities on the other side. The confrontation or the impact between territory demand and supply is realized by means of a Territory Balance, that represents the verification of compatibility between required resources and available resources.

13.4 The territory balance

The territory balance may be conceived as a transformation of territory supply or input, in a territory use vector, or output. Naturally the inputs must be classified according to a qualitative typology inherent in the territory itself, independently from the current uses, unless such uses have compromised the territory to such an extent as to render impossible its re-qualification: in such a case these uses become an organic part of the quality offered. The outputs, on the other hand, are classified, as said, according to the various typologies of use inherent in the present or future activity programs in question.

The crossing of the two classifications, accompanied by the appropriate measurements, gives rise to a table of territorial inputs and outputs, in which the inputs represent the qualifications of the territory, and the outputs its use destination. We have called this the table of territory supply and demand (see table 13.1, which is an aggregated version extracted from Archibugi, 1982).

The table can be constructed with factual findings at a given time. It constitutes a statistic finding that can be expressed by numbers, even without a geographic/cartographic point of reference, with suitable units of measurement that are to be studied case by case. Or it can be expressed cartographically, for example by assigning a color to the territory qualifications, and a net to the uses of these qualifications. This table may also be programmatic or projected if it refers to a future time and if it expresses policy intents. In both present and future state cases, the numeric and/or graphic representations are static. The territory balance can also be expressed in dynamic terms, by finding a form of expression of the variations that intervene between the present state and the future state. Before giving form to the future state of the table, one passes through the 'balancing' operation between the territory programmatic demand and the available supply.

If in the representation of the present state, the equilibrium between territory supply and demand is guaranteed by the accounting equation of the territories actually available and actually used, in the representation of the future state an imbalance could occur between territory supply and demand. Such an imbalance must be evaluated, measured and eventually eliminated in the planning process, if the plan is to have coherence, compatibility, and therefore feasibility. The future state table of supply and demand, or the programmatic table of territory use, becomes thus the tool of control for the coherence and feasibility of the plans.

The confrontation between a present state and a future state, and the measurement of the changes that ensue gives rise to a dynamic evaluation of the territory balance itself. In fact the confrontation is expressed by means of a change of numbers and spaces. The table of these changes provides a dynamic territory matrix, an exit from a preceding use to a new use.

The 'dynamic' matrix, the sums of which equal each other, obliges us to consider not only the overall availability's, but also to evaluate the impact that any possible plan process intends to exercise on the territory and on the transformation and re-qualification of the same. Moreover, if in numeric terms, this dynamic matrix representing programmatic changes obliges us to verify quantitative coherence at every stage of advancement of the decision-making process. In spatial or cartographic terms, such a matrix forces even more complex analysis of appropriate use of locations.

Table 13.1 Territorial (or environmental) supply and demand.

Environmental Resources (Supply)	Spatial Uses (Demand)					
	Environment Conservation (and its characteristics)	*Residential Centres (and their typologies)*	*Free time (and its qualifications)*	*Agriculture (and its possible sub–utilisations)*	*Industrial Locations (and Mining)*	*Transport and Service Infrastructure*
A. High Mountainous Areas						
1. Bi–seasonal Mountainous Areas						
2. Seasonal Mountainous Areas						
B. Sub–mountainous areas						
C. Hilly areas						
1. Steep slopes						
2. Medium slopes and variable morphology						
3. Light slopes, uniform and plateau land						
D. Watery and irrigatable plainland areas						
E. Coastal Areas						
– Beach area						
– Rocky area						
F. Mainly wooded areas, forests and woodland in special locations						
G. Areas with specialised cultivation						
H. Areas with historic centres						

N.B. For each relationship there should be considered the disaggregation of the data in: *proper uses*: promiscuous, non–promiscuous ; *improper uses*: promiscuous, non promiscuous.

* Obviously the classification of environmental resources in rows and that of the use of territory in columns given here only represents a summary. In effect it would be much more disaggregated according to the special requirements of each Plan and the special characteristics of each territory

Source: F. Archibugi, Principi di pianificazione regionale (Principles of regional planning), Angeli, Milan, 1982, 2nd. Ed., p. 183, Vol. 1).*

13.5 The economic evaluation of territory

The LURM thus described may moreover constitute a valid tool of plan and project evaluation. In fact the evaluation of plans has suffered right from the start from scarce reference to the national interest. The methodologies worked out for plan evaluation, not unlike those created for the evaluation of single plans (from the cost-benefit analysis approach applied to plans and projects), have adapted the analyses to an objective situation in which there is an absence of significant national planning, from which can be drawn valid criteria and references in order to compare the single evaluations of plans, projects, or programs.

This has happened for cost benefit analyses, that despite recognized demand, have not generally obtained from the competent authorities and from the appropriate planning processes the necessary national parameters of reference. This is happening because of the multiple procedures of environmental impact analysis that, beyond their undoubted descriptive and cognitive value, have difficulty in becoming instruments of evaluation and thus of decision, exactly because they are not performed through evaluation 'parameters', as they can be formulated only from one national and overall point of view. This happens also, at least judging from the albeit limited but important experience had, for the methodologies of plan evaluation that have recently been introduced, whose reference parameters are inductive and arbitrary, and in any case, elaborated by plan formulators and evaluators case by case, with a low level of information and a high degree of superficiality.

To be thorough, even if it is a bit marginal to the subject being dealt with, we will mention that in the case of territorial plans, the reference parameters are obviously not the shadow-values of a monetary type, commonly considered necessary for a cost-benefit analysis (shadow-wage, investment shadow price, social discount rate, etc.), but rather non-monetary criteria, and some weights given to such criteria, or to objective indicators that are necessary in order to render comparable the single plan or project analyses. In the case of the territorial plans, a fundamental reference parameter will be moreover the design of a territorial framework of reference that will select and suggest the appropriate use of each part of the national territory and fix use priorities according to needs and to that, which is urgent.[10] The physical balance of the territory, extrapolated from the LURM in the above mentioned ways, may give rise to an economic balance of the Territory, if we assign a monetary price/value to its physical portions. It is information that, however collected, would significantly enrich the knowledge of the available territorial resources and of the territorial costs of the plan operations.

Above all, a market price can be given to each portion of matrix territory. The methods of estimating such a price are long established and

systematically taken into consideration in the disciplines of economic evaluation. The so-called market prices reflect the exchange values of the territory units with regard to the existent supply and demand, and in consideration of the personal and individual convenience of the users.

This convenience is translated into the relative appreciation of such units to which must be added the deriving surcharge, when necessary, from the control (monopoly) that, from the side of the supply, is exercised by the 'owners' and is to be understood as the generator of a position rent. As is known such a control is relatively diffuse in the real estate sector, in the sense that when a territorial asset has overcome the level of purely agricultural use, it becomes almost always a rare and irreplaceable asset when in fact it is not as well irreproduceable.

But the collective convenience in the use of these portions of territory is almost never reflected in the market prices. Since the collective demand is almost always a public demand, and since the public body at every level is a very poor buyer, the market price is almost always determined by the private market. This market price is then used for transaction by the public bodies, if other forms of acquisition do not intervene that, however, do not in any way decide the price (eg. requisitions, expropriation, with or without indemnity etc.).

The price or value of public interest of the various portions of territory, even if practically unexplored, apart from some rare exceptions, should not be difficult or impossible to determine. It could be estimated with criteria not dissimilar from those with which the non-market price is estimated: ie. as a meeting point of the curves of supply and demand. The only difference is that such curves would be extrapolated from the plan rather than from the market; and the thus decided price, rather than the denomination market price would deserve that of 'plan price'.

Such a price would be assigned by the public authority, based on indications of the plan evaluations, with reference to the scarcity that the LURM would reveal of various portions of territory supply with respect to the needs and the resulting demand of the corresponding territory, that the plan itself would express (naturally for appropriate uses). It is a question of an 'assigned price', a sort of shadow price or 'plan price' - as one prefers - extrapolated from the territory supply and demand 'curves' for the given typologies of qualification and appropriate use, arising from the plan hypotheses.

13.6 The utilization of the LURM

The existence of an 'assigned' price, or price of reference, allows for the calculation of the positive and negative economic effects, expressed in money,

ie in terms of gains and benefits and losses or costs, of alternative land uses, that correspond to alternative types of consumption of environmental-land resources. This applies in all those cases in which there is determined competition of use for a given territory (or territory typology), and it would allow also for the monetary expression of the costs of all the improper uses of the same territory.

The LURM in its monetary reference form could constitute the 'reference parameters' or indicators that are indispensable in order to give concreteness, reliability and systematicness to the single evaluations of projects and programs that involve the territory and the environment. In fact having a price for various areas with regard to the reasonable use that can be made of them in an overall planning framework, and with regard to the relative scarcity of such areas, constitutes not only a factor of knowledge and learning for the evaluation of the most convenient uses of an area, but also a method for the evaluation of projects and programs that include alternative uses of such areas. After all, this is spoken of when in the language one refers both to the possible impacts (usually negative) of the projects on the environment, and to the projects of utilization of areas and territorial resources[11].

13.7 Other instruments of evaluation interlinked with the LURM

The idea of a LURM must naturally be accompanied by a series of concrete decisions that, on the one hand, highlight the feasibility of construction, and on the other the feasibility of utilization.

Above all it must be accompanied by other equally essential instruments which constitute, as said at the beginning of this contribution, essential requisites for authentic land use planning. These other instruments which we will only touch on here, and refer to other writings for more details, are: the identification of the appropriate territorial units of evaluation and planning; and the definition of indicators and parameters of land loading capacity.

The LURM, in fact, must be constructed for an appropriate territorial unit of reference, if it is going to have any validity. If the unit is inappropriate, i.e. it does not have the requisites to permit a significant evaluation of the land demand and supply, the application of the LURM has no sense[13].

Moreover, the LURM, once constructed, may function if the quantifications which are inserted in it are based on standard and parametric values which render its relations meaningful. Without these standards and parameters the use of the LURM becomes a waste of time[14].

On these other two instruments, which are so important in order to make the LURM effective, it is necessary to reflect further and carry out the

consequent research, which for the moment lies outside the scope and limits of this contribution.

Notes

[1] Professor Franco Archibugi is director of the Planning Studies Centre, Rome, Italy.

[2] This research has been carried out in Italy with a contribution from the Italian National Research Council, in the context of preparatory studies for the creation of a 'Ten-year plan for the Environment' and a 'Territorial Framework of Reference' (the 'Decamb' and 'Quadroter' projects).

[3] See on these postulates another contribution by the author (Archibugi, 1994).

[4] We are referring, for example, to the 'Environmental Impact Matrix' developed by Edmunds and Letey (1973), or to other forms of environmental quality matrices such as Nijkamp's 'Environmental Quality Profile Matrix' or the 'Environmental Quality Matrix for Various Uses' (1977).

[5] A balance of territorial needs, both as location requirements and as space requirements is taken into consideration in any planning manual worthy of the name. See the highly detailed manual by Chapin (in the third edition of 1985, ed. By Chapin & Kaiser), in particular Chaps. 11 and 12.

[6] A more detailed explanation of the LURM is to be found in the author's manual (Archibugi, 1982, 2nd Ed.). Further technical considerations also in Archibugi, 1989, 1990.

[7] In the didactic work mentioned above (Archibugi, 1982, p. 181-184).

[8] The definition of the territorial typologies with which to articulate the two vectors indicated is in fact the first task of the above-mentioned research, and already there are some important problems. The problems of the classification of territorial resources (that we will consider as 'supply') have long been dealt with and debated. It is useful to recall amongst the best treatments of subject the classic work by Chapin (1965) that is notably improved in the 3rd edition (Chapin and Kaiser, 3rd ed., 1985).

[9] On the conception of planning there is obviously ample specific literature, under the nomenclature of 'planning theory' (see Alexander, 1986; Chadwick, 1971; Faludi, 1973a & 1973b; McConnell, 1981). See also the papers given at the First World-wide Conference on Planning Science (Palermo, 8-11 Sept. 1992). A selection has been published (in Italian), edited by F. Archibugi and P. Bisogno in 'Per una teoria della pianificazione' (Towards a Theory of Planning), Prometheus 16/17. 1994. The papers are about to be published (in English) in 'special issues' of

various journals: Socio-economic Planning Science, European Planning Studies, Evaluation and Program Planning, Social Indicators Research.

[10] This in effect was the case with the research experience had in Italy, from which this contribution has been drawn, which aimed essentially at constructing a National Territorial Frame of Reference. Greater details can be found in Archibugi, 1994.

[11] It is obvious that the availability of 'national' parameters, of 'shadow-prices' of the territory, could give meaning both to cost-benefit analysis applied to territorial projects (especially in the 'Planning balance sheet' version proposed by Lichfield and colleagues, 1975) and in the procedures of 'Environmental Impact Assessment' in their various versions. See on this last point the general comments contained in Archibugi (1988).

[12] The iterative sequences in the planning and evaluation processes are widely treated in all the writings concerning 'planning theory' mentioned in Note 9.

[13] The concept and modality of identification in the appropriate territorial unit of analysis, evaluation and planning have been developed in by the author in numerous other works (see Archibugi, 1990, 1991, 1993).

[14] For the definition of environment indicators and parameters, see the work carried out by the Planning Studies Centre on behalf of the Ministry of the Environment (Ministry of the Environment – Planning Studies Centre, 1992).

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