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AN INSTRUMENT FOR ENVIRONMENTAL PLANNING: THE LAND USE RESOURCES MATRIX

by **Franco Archibugi**
University of Naples and Planning Studies Centre, Rome
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This contribution wishes to discuss the results of theoretical and practical research for the definition of an appropriate method for evaluating the environmental impacts of anthropic activities, in the context of land planning processes[1].

Founded on some basic postulates[2] concerning the particularity of the methodological approach of planning to the evaluation of environmental policies, an appropriate methodology consists in using instruments of analyis and evaluation which are identified as:

– a "land use resources matrix" (LURM)
– the identification of the "appropriate territorial unit of evaluation";
– the definition of indicators and parameters of loading capacity for the various territories.

In this contribution, we will limit ourselves to illustrating 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 of evaluation.

1. Why a Land-use Matrix?

We intend to discuss a method of land use evaluation, that could constitute a useful instrument - as a package of reference for a more reliable and coordinated level of environmental impact evaluation - by means of its anchorage to a system

[1]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). This text is a reduced version of a background paper prepared for the international Conference on "Urban Planning and Environment" (promoted by the Universities of Groningen (Netherlands) and State University of Washington (USA) in Seattle, 2-5 March 1994..
[2]See on these postulates another contribution by the author (Archibugi, 1994).

of (expressed or simulated) "national parameters".

This method consists of the construction and utilisation of a *"Land- Use Resources Matrix"* (LURM) - actual and programmatic - at which we should arrive, by means of a coordinated series of technical-economic enquiries and political evaluations, of the land resources available.

The aim is to provide "parametric values" for the said physical resources - with regard to their availability (supply) and gauged social demand. It is a case, in other words, of ensuring a conventional "value", of national interest, for the territorial and environmental consumption of resources as a result of the development of human activities: this for the purpose of evaluating the overall social costs and benefits of such consumption.

After a brief examination of the nature and characteristics of the LURM, we will look at the possible utilisations to then proceed to the evaluation of programmes and territorial projects, in the context of the organic processes of territorial or environmental planning.

In this, however, we will not examine the various methods of evaluation discussed today and applied to plans and projects with respect to which the LURM may constitute, certainly *not* an alternative, but simply a support. By not entering into the merit of the discussion of such methods, we will avoid examining towards which of these methods the LURM may be - so to speak - more akin, or rather towards which it shows greater or lesser disposition to lend such support.

2. Nature and Characteristics of the Land-Use Resources Matrix

The LURM is not different, in its basic purpose, from other "matrices" that in the literature have been proposed in order to facilitate instrumentally the analysis and evaluation of socio-economic projects with regard to their environmental impact[3].

Nevertheless in our description we have above all tried to rigorously adhere to a twofold "vector", corresponding to a twofold way of looking at the "territory":

- at the "territory" as the *availability* of a resource, having a multiplicity of original "qualifications";
- at the "territory" as an object of anthropic use, according to a *taxonomy of use that is appropriate* for the purposes of planning.

In other words, we have looked at the territory as a resource *"supply"* and as a resource *"demand"*.

This particular way of constructing a Land Matrix, deserves some justification.

Environmental malaise is always an *imbalance* between *demand* for environmental resources, from which arises the consumption of the same, and the *supply* of the same resources, which are - like all resources - by definition limited.

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

The task of planning is aggravated, with respect to other socio-economic disequilibria, by the fact that the greater part of the supply of environmental resources is constituted by resources that cannot be *reproduced*, and which represent absolute, and not relative, constraints (on places, times, cultures, productive capacity, etc.).

In the so-called urban environment as well, environmental imbalance (whether it be from pollution, traffic congestion, the marring of the urban landscape, or the loss of social communication, etc.) is between the demand for the use of urban activities and the supply of environmental resources.

Thus the first analytical procedure required is that of listing:

- on the one hand, all the *land-use demands*, which satisfy activity needs (which satisfy in turn the citizens' needs); demands that are classified by type of activity or type of need to satisfy: e.g. housing, squares, roads, industrial zoning, spaces and public buildings for use, green areas to be used, zoning for pastimes and sport, shopping centres, and so on;
- and, on the other hand, all the available land resources (which constitute *land-use supply*), 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 anthropic pre-existencies (above all in the case of city areas): e.g. historic buildings, the urban landscape, green conservation areas, land for agriculture, areas for public infrastructures, and so on.

The two lists may face each other as on a scales[4]. But they may also constitute the vectors of a "land use and resources matrix" (LURM[5]), 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 (or spaces).

The construction of a LURM is not easy; but - albeit in different forms and approximations - it is an essential requirement for correct ecological planning of the "city" and region. The problems arise when the same land supply unit may at the same time satisfy several demands, and accept several uses, and thus be a demand for *promiscuous* use. We have classified such promiscuous uses as *proper* or *improper*[6], 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 whilst not being imcompatible with another (commercial activities with residential housing, for example) becomes so because of the over-crowding it creates.

The LURM constitutes a computational and evaluating model of the compatibilities and incompatibilities not only between alternative uses for a single unit of an available resource; but also of the compatibilities and incompatibilities

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[4]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.

[5]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.

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

of a demand for use - actual or policy-oriented - with the existing or potential available resources. The LURM, in short, constitutes an instrument for evaluating the opportunity cost of the use of a resource: i.e. of the advantage lost in terms of alternative uses.

And, in as much as it is an instrument of evaluation, it constitutes also the instrument offered by the planner to the decision-maker for its trade-off between costs and benefits, for fixing its targets and for rationalising, finally, its plan decisions.

The lay out of the Matrix hinges therefore on the confrontation and resulting impact of these two conceptual entities: that are obviously to be further defined, analysed, measured and evaluated[7].

On the other hand, we consider such a lay out as conforming with the appropriate approach to the process of physical planning (and even planning *tout court*) seen as the impact of *objectives and programmes of action* (demand) with respect to the *means, instruments and resources available*[8].

In the LURM, therefore, are placed on one side the data relative to *available* territory or *"supplied"* for the various uses made of it, and which we need. On the other side are placed data relative to the territory *requested* or *"demanded"* for the existent activities, or for the activities that the planning process would want to develop.

The confrontation or the impact between Territory Demand and Supply is realised by means of a *territory balance*, that represents the verification of compatibility - in the territorial and urban field - between required resources and available resources, between programmes and means.

3. The Territory Balance

The territory Balance may be conceived as a transformation of territory supply (understood as *input*) in a territory use vector (understood as *output*). Naturally the *inputs* must be classified according to a qualitative typology inherent in the

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[7]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 the subject the classic work by Chapin (1965) that is notably improved in the 3rd edition (Chapin and Kaiser, 3rd ed., 1985)

[8]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.*

territory itself (independently from the current uses, unless such uses have compromised the territory to such an extent as to render impossible its "requalification": 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 programmes 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 Table *"Table of territory supply and demand"* (see a summary and aggregated version in Table 1 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, on the other hand "cartographically" (assigning, for example, a colour to the territory qualifications, and a "net" to the uses of the same).

The Table may also be *"projectual"*, or *"programmatic"*: if it refers to a future time ($t + x$) and if it expresses policy intents.

In both cases there are numeric and/or graphic representations of a "static" type: whether *"present"* or *"future"* state.

The territory Balance can also be expressed in "dynamic" terms. It is a matter of 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": an imbalance that must be evaluated, measured and eventually eliminated in the planning process, if the plan wants to ensure its fundamental requisite of 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 (or would ensue in the projectual hypothesis), the confrontation in other words between the *"actual"* Table and a *"programmatic"* Table, gives rise - as said - to a *dynamic* evaluation of the Territory Balance itself. In fact the confrontation is expressed by means of a *change* (of numbers and spaces): with less or more numbers and spaces.

The Table of more and less, i.e. of *"variations"* generates a dynamic territory Matrix: an entry of territorial quotations from a typology to a different use from

the preceding one; an exit from a preceding use to a new typology.

The "dynamic" matrix, the sums of which equal each other obliges us to consider not only the overall availabilities, but also to evaluate the impact that any possible plan process intends to exercise on the territory and on the transformation and requalification of the same. Moreover, if in numeric terms the "dynamic" matrix - that is of the diachronic and "programmatic" changes - obliges us to verify quantitative coherence at every stage of advancement of the decision-making process, in spatial (cartographic) terms such a matrix forces even more complex analyses of coherence and rationality: in as much as they are linked to the rational and *"appropriate"* use of locations and to the typological *"direction"* of the change and development.

4. 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, that has had some methodological developments in the last decades, 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 programmes.

This has happened for *"cost benefit analyses"*, that despite recognised 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.[9]

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 sytematically 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 irriproduceable).

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, which 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" -

[9]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.

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 (for all those that we would want to formulate in the planning process).

5. The Utilisation 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 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 systematicity to the single evaluations of projects and programmes 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 programmes 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 utilisation of areas and territorial resources[10].

Certainly the assigned price, is assigned also with regard to the plans and programmes - as said - and to the territorial "load" that decide (as territory "demand"); whilst the evaluation of plans and programmes would be carried out with regard to the assigned prices. Without doubt we are in the presence of a "circular" type of problem (in this case as in many others in planning procedures). But if we bear in mind the iterative sequence of a planning and evaluation process the cognitive and heuristic nature will be grasped[11].

6. Other Instruments of Evaluation Interlinked with the LURM

The idea of a LURM must naturally be accompanied by a series of concrete

[10]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).

[11]The iterative sequences in the planning and evaluation processes are widely treated in all the writings concerning "planning theory" mentioned in Note 8.

decisions that have, on the one hand, to highlight the feasibility of construction and, on the other, the feasibility of utilisation.

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 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;*
- 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[12].

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[13].

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.

[12]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).

[13]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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Table 1 - **Territorial (or Environmental) Supply and Demand**

Spatial Uses (Demand)

Environmental Resources (Supply)	*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 IRRIGA- TABLE PLAINLAND AREAS						
E. COASTAL AREAS 1.Beach area 2.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 use*s: 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

(taken from F. Archibugi *Principi di pianificazione regionale* [Principles of Regional Planning]