COOPERATION IN MEDITERRANEAN SYSTEMS RESEARCH

by ANTHONY MACELLI*

THE purpose of this paper is to suggest methods of analysis which could be used as the basis for the co-operation of several Mediterranean Universities and other research institutions. Each could assign itself part of the global task and later one or two workers from each institute could meet and carry out the subsequent integrating of the various outcomes into one model (e.g. a simulation and forecasting model) or other analytical tool (e.g. a checklist of important factors, a tree-graph of causes and effects and event probabilities). Such a tool could then, while undergoing continual elaboration and updating, be used as the basis for the co-ordination and management tasks of a central Mediterranean institution of the type that has recently been proposed.* (Serracino Inglott, 1976). The institutional proposal, in slightly modified form is presented in Fig. 1.

It is becoming increasingly necessary to visualise the immediate future along these lines, because of the increasingly urgent problems that face the region as a whole. Among these are the seriousness of industrial and agricultural pollution of this closed sea, not least in terms of its effects on tourism; the need to find markets for Mediterranean agricultural products; the extensive great-power presence; the overfishing problem and the inequitable exploitation patterns of fishing areas; the recent technological potential for oil and mineral exploitation of the seabed; the related problem of the demarcation lines for the sovereign zones, the economic zones, and what may become the 'common heritage' of the high seas; and the broader problem of underdevelopment, a problem which may be considerably alleviated through the transfer of capital from the EEC, through using the 'oil money' and immigrant repatriation.

If it is desired to produce a model of Mediterranean activities which are of interest, and if the model is to be useful for heuristic purposes and possibly for forecasting and management purposes,

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(above) Existing Mediterranean Institutions

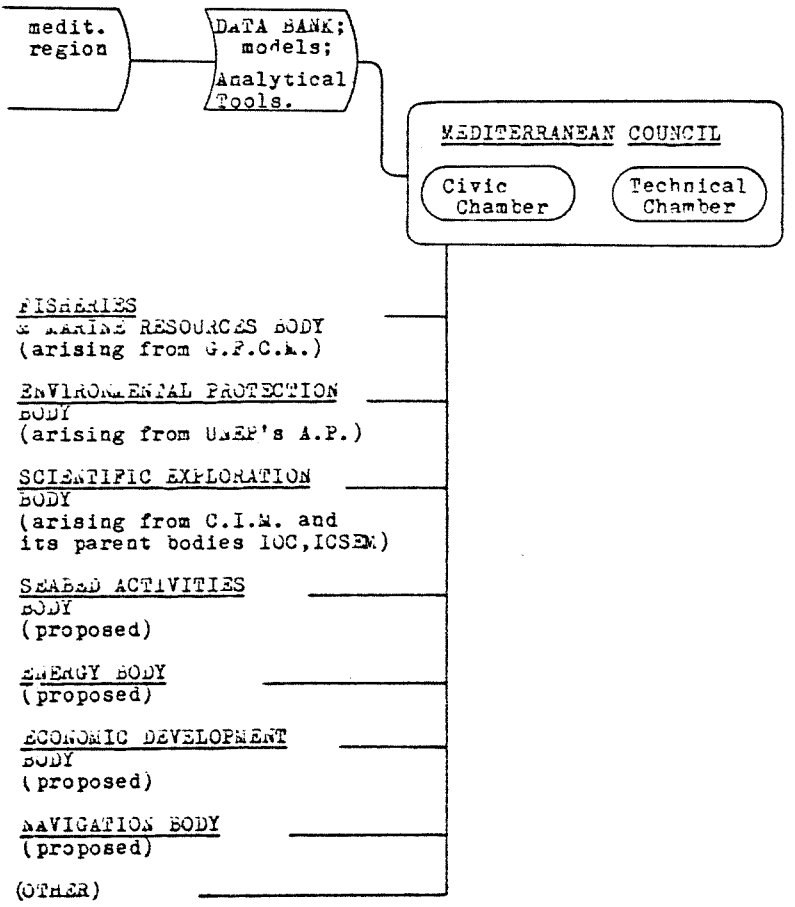

Fig. 1. *Proposed Integrated Regional Institutional Framework.* (after Serracino Inglott)

it makes very little sense to merely come up with regression equations that faithfully mimick the behaviour of certain measures over the past years.

Both in spite of their possible complexity these equations would not be very useful for understanding and prediction, although they might be very good summaries of past data. They 'describe' without 'explaining'. It is thus desirable to arrive at a set of important factors and set of important interaction processes among these factors or measures. The use of simple regression equations is not excluded in determining the shape of some of these relationships, but for many others no such data will be available and intelligent guesses have to be made about the approximate mathematical shape. Thus when the whole model is finished, the effect of the size, of the complexity, and of the imprecision of some of the equations will combine to create an overall behaviour of the model that does not faithfully mimick historical data. Notwithstanding this, it may be as valid a way of describing the present and the future as one can get, provided that the choice of factors and processes has been carried out with sufficient insight. The reason is that the underlying structure of the system, rather than its superficial behaviour will have been determined.

Here we shall assume that the objective is to arrive at a set of factors, or measures, grouped by compartment, as well as a list of the linkages among these factors in terms of influence, using the paradigm of dependent/independent variables. When some knowledge is obtained about these causal and mutual-causal linkages, a computer simulation model may be constructed if desired. The manner in which one can do this is described in another paper (Macelli, 1976). However, other kinds of models and analytical tools may be acceptable alternative outcomes.

We may envisage a set of n subregions making up the Mediterranean. At a high level of aggregation, n will be small, and one of the subregions would be a group of countries. At a lower level of aggregation, subregions would be identical with countries, while at a still lower level, a subregion must be subnational, for example Southern Italy, or Rhodes. We also imagine m sectors of interest within each subregion. For simplicity we choose the sectors so that they occur in every one of the n regions, although the parameter values and the nature of the relationships may differ in the corresponding sectors of different subregions. A third list might be w parts of the common Mediterranean environment (such as the atmosphere and the high seas, etc.) including also some parts of the broader world environment, the latter considered in highly aggregate form.

The set of all t, k pairs such that the t'th subregion significantly affects the k'th subregion, in at least one of its sectors, is*

$$\phi = \{(t,k) | 1 < t, k < n;\ t, k \text{ significant inter-subregional link}\}$$

For one subregion, the i'th sector influences the j'th sector, usually through a variety of processes. Some i, j pairs can be excluded for convenience if not very significant. The set of (i, j) pairs which remain is denoted by

$$\psi = \{(i,j) | 1 < i,\ j < m;\ i, j \text{ signif. intersectoral local link}\}$$

We assume that subregions share much of this pattern of internal linking among sectors. If we now consider typical 'foreign' intersectoral links, namely those between the i'th sector of the t'th subregion as cause and the j'th sector of the k'th subregion ($t \neq k$) as effect, we may denote the set of included (i, j) pairs by

$$\psi' = \{i,j) | 1 < i, j < m;\ ij \text{ signif. intersectoral foreign link}\}$$

If we now let ${}_tS_i$ denote the i'th sector of the t'th subregion, and ${}_tS_i \cdot {}_kS_j$ denote an intersectoral 'foreign' or 'local' interaction, then the set

$$R = {}_{ti}S \cdot {}_{kj}S \mid (i,j) \in \psi \text{ if } t = k;\ (i,j) \in \psi' \text{ if } t \neq k;\ (t,k) \in \phi\}$$

is the set of all intersectoral interactions which are to be considered. It is useful to get some idea of the number of elements in this set, or $N(R)$. If each subregion is significantly affected by f others besides itself there are $n(f+1)$ region-region links if we include the n cases of a subregion interacting with itself. For local intersectoral interactions, suppose that each sector is on average influenced significantly by h others; then we have $m(h+1)$ sector-sector links within each of the n subregions. For foreign intersectoral links, we might expect that for a given pair of interacting subregions, a sector in the second is influenced by an average $(h+1)$ sectors from the first, where h' is likely to be considerably less than h. Thus for any of the nf pairs of linked subregions, we expect $m(h'+1)$ foreign intersectoral links, a total of $nfm(h'+1)$ such links. Thus

$$N(R) = nm((h+1) + f(h'+1))$$

The rapid rise of $N(R)$ for quite slow changes in the other para-

*In set notation, $\{m | m \in M, \text{ etc.}\ldots\}$ means 'the set of all elements or entities such as m where m is a member of the set M etc. ...'

meters in this equation is illustrated below, for enabling a choice to be made of the size of the system to be studied

number of subregions	n	5	5	5	20	30
number of sectors in each subregion	m	5	5	4	10	10
inter-subregional connectivity	f	4	3	3	6	6
intersectoral (local) connectivity	h	3	2	2	6	6
intersectoral (foreign) connectivity	h'	2	1	1	2	2
number of intersectoral interactions	$N(R)$	400	225	180	29,400	44,100

It is clear that for any useful number of regions and for several intra-subregional sectors, the connectivity h' across subregional boundaries between one sector and a foreign one must be kept to the absolute minimum in order to keep the task down to a size that is manageable by a small team of workers. With 30 subregions each having 10 sectors of interest, and with local intersectoral connectivity of 6 (each sector affected by 6 others in the same subregion), and if each sector is on average affected by only 3 foreign ones in every typical subregion – subregion link, then there are 44,000 intersectoral links to investigate in spite of the fact that each subregion is influenced by no more than 6 foreign subregions. These simple considerations should help to place in perspective the problem of trade-offs between manpower for research and feasible levels of resolution and depth of research. (See Figs. 2, 3).

The appropriate method appears to be to start with a highly aggregate grouping of sectors, and also of countries, and attempt to eliminate some cells representing insignificant interaction possibilities. A cell is retained if there is a link between the first and the second subregion through one or more 'processes' (flows of influence, materials, money, etc.). Wherever possible lists of likely processes should be general so that they can be modified for different subregion or pairs of subregions. The matrix of cells obtained by crossing the list of sectors with itself (fig. 5) may help at this stage. There will be one matrix for *local* interactions, with n subsequent variations, one for each subregion. After the unrequired cells are eliminated, the cell indexes will form the set ψ. In such a matrix the rows and columns dealing directly with Oil, Tourism, and Ecology will be emphasised more than the rest, with

the result that some cells are de-emphasised. In the latter one need enter notes only about processes which are necessary to make complete and consistent the entries in the more important segment of the matrix. In this type of matrix one can indicate directed interactions, that is, there is one cell for the influence of sector *i.* on *j* and there is another cell for the influence of *j.* on *i.* Also, each cell on the diagonal, such as (k,k) refers to only one sector, and so it can be used to enter a broad model of *intra*-sectoral behaviour including the main variables and their pattern of linking. The extent of detail in the diagonal cells will depend on one's research emphasis: thus, for example, if one is interested mainly in the interactions between certain sectors and the demography sector, it will not be necessary to work towards a simulation of the demographic sector itself, although it will be necessary to represent at least descriptively or exogenously some of its broad characteristics, e.g. population growth.

Taking from fig. 3 the D-list of only 8 sectors we have constructed such a matrix, but we have found that at this level of aggregation it is unrealistic to eliminate any cell, because a significant process of intersectoral interaction almost always exists, owing to the broadness of definition of a sector. However, if nothing else such a matrix provides a classification scheme for intersectoral interactions within one subregion, and it can help a consideration of differences among subregions.

A similar matrix is obtained (Fig. 6) for foreign intersectoral influences, where the cause-sector is in a different subregion to the effect-sector. This is a kind of prototype for 6 foreign-type matrices, one for each of the *six* subregions (again taking the most-aggregated list) which are to be on the receiving end of foreign interactions. At this level it will be possible to eliminate many of the cells, since foreign interactions are much smaller in number. Feedback loops, or closed paths of interaction, will appear at this stage: they may be seen by examining the one local and the six foreign matrices together. For facilitating the use of these 'foreign' matrices, it may be advisable to start with another matrix, formed by crossing the list of subregions with itself. If there are six Mediterranean subregions, the 36 resulting cells may be used to jot down the significant intersubregional links and flows, for example—emigrant flows from the Maghreb to Iberia; revenue flows, oil flows, agricultural dependencies, tourist flows, etc.

Notes of the above-mentioned investigations might include preliminary lists of significant factors, sources of data, accessible

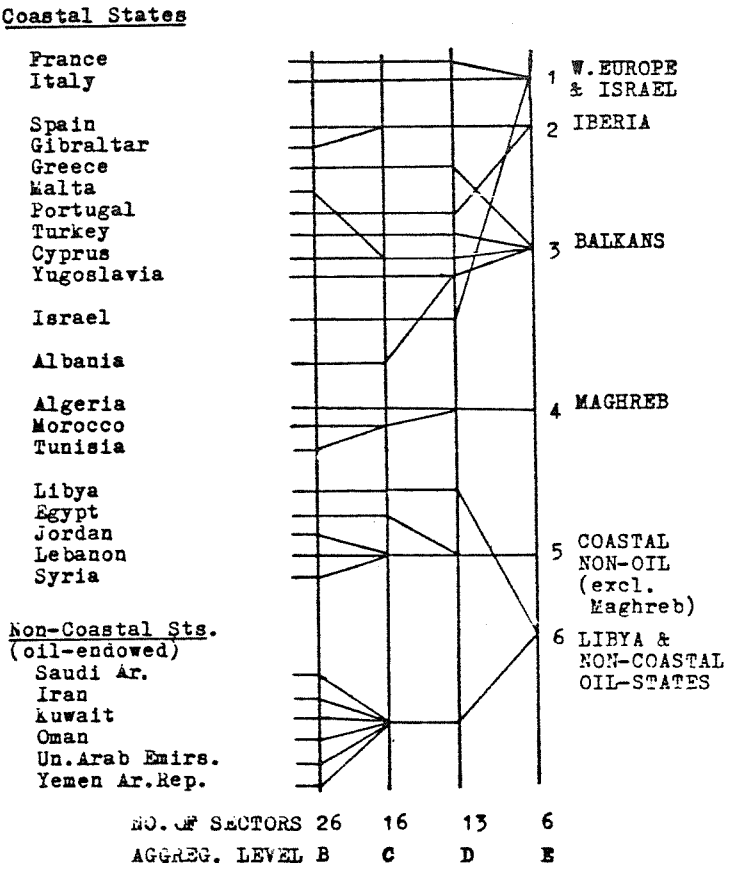

Fig. 2. *The Mediterranean: a possible series of economic and geopolitical aggregations for analytical purposes* (in the context of an Oil/Tourism/Ecology approach)

Notes:

1. The lowest aggregation level A (not shown) would include the major islands and other subnational regions.

2. A very useful level appears to be D, with 13 units or subregions. No level higher than G, with 6 subregions, would appear to be of much use.

3. It is assumed that the Maghreb is a better context for Algeria than would be the group of oil-exporters. This and similar assumptions may be altered.

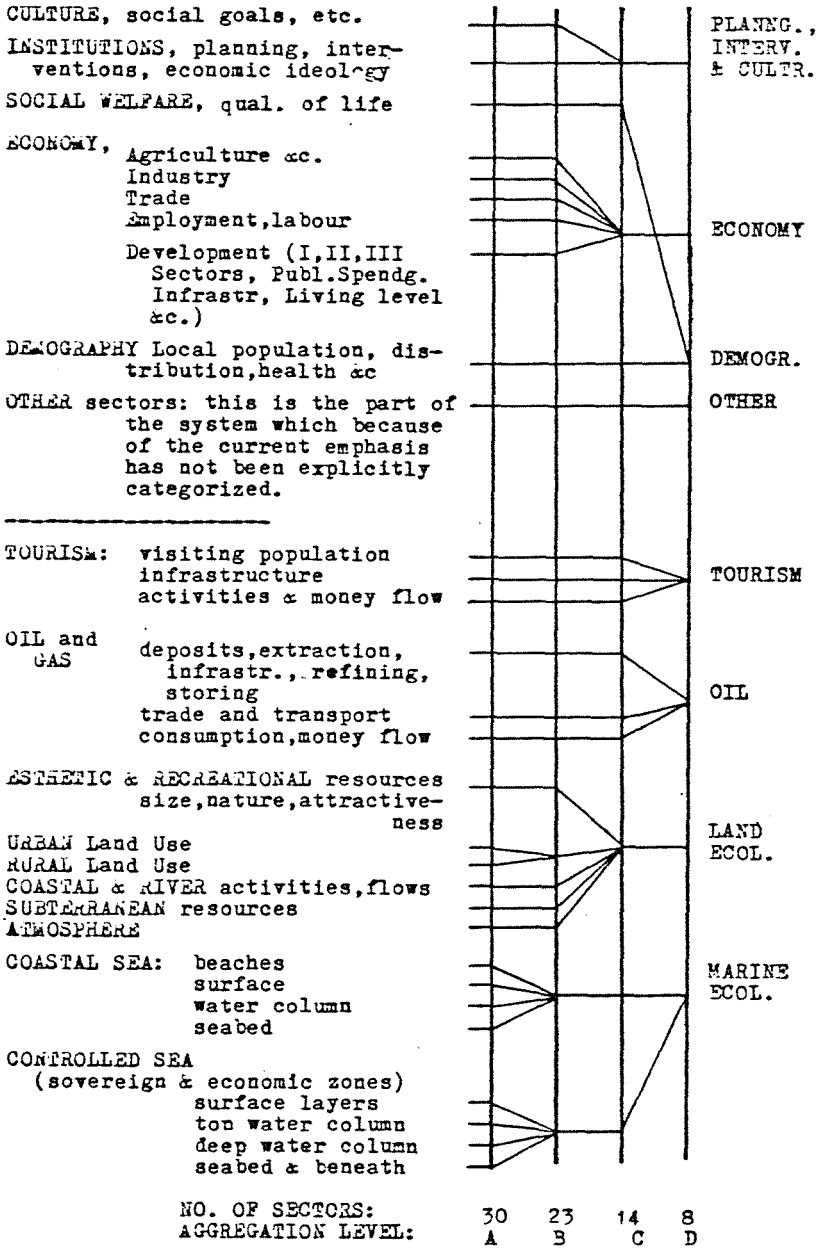

Fig. 3. *Sectoral Resolution of the Mediterranean System* (The list applies to the Tourism/Oil/Ecology approach, relates to one subregion, and excludes common space.)

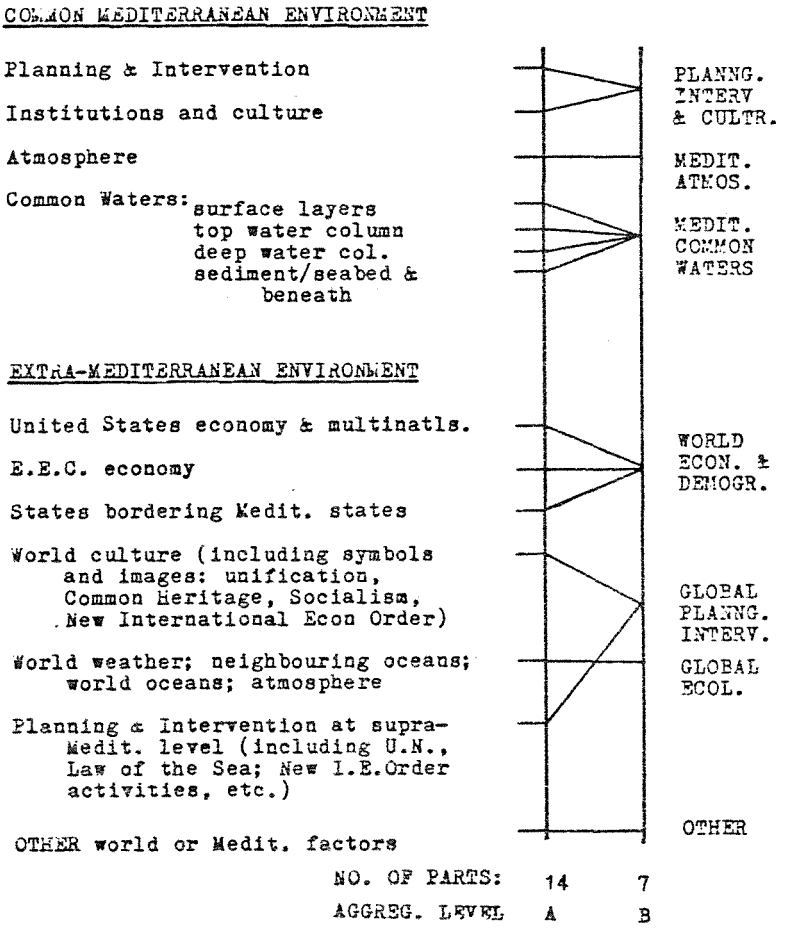

Fig. 4. *Partitioning of the Common Mediterranean and of Global environments.*

Note: Each of the parts listed to be checked to see whether it influences, or is influenced by, local or foreign intersectoral interactions among the sectors listed in Fig. 3. (A foreign interaction is one that takes place across the borders of subregions in Fig. 2.)

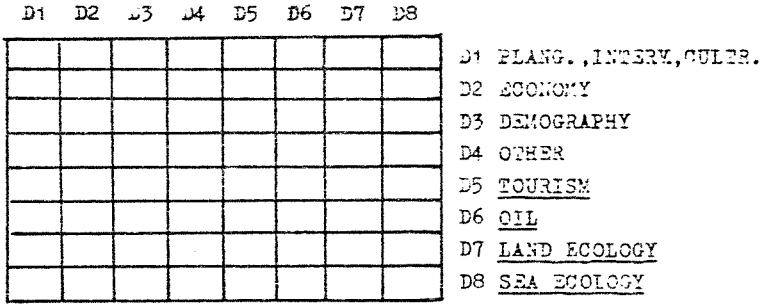

Fig. 5. Intersectoral interactions within a subregion.

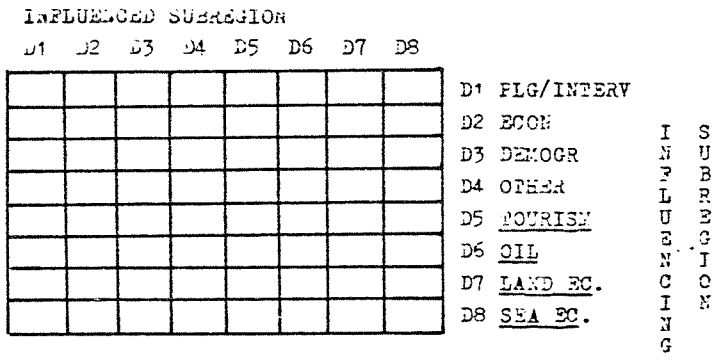

Fig. 6. Foreign intersectoral interactions in general

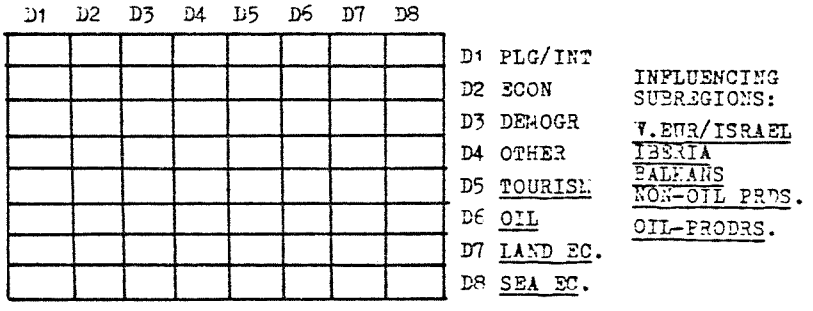

Fig. 7. Foreign intersectoral interactions influencing a specific subregion, in this case the Maghreb.

Each cell examines, possibly comparatively, the influence of up to five subregions on the Maghreb. This is one of 6 such diagrams which would exhaust such interactions.

specialists, lists of interaction processes, etc. Both the local and the foreign intersectoral influences will now be checked for connections with any part of the common environment. The partitioning of the common Mediterranean and the world environment is illustrated in Fig. 4. In some of the intersectoral interactions considered, the common environment may act as intermediary, or as a source or sink for some of the materials involved. Thus, we may examine each 'allowed' intersectoral link in terms of the questions: (a) Does this affect the common environment? (b) Is this affected by the common environment? As before the result of this investigation will include lists of significant factors and processes, the latter first in verbal then in rough mathematical form. A number of large-scale processes remain to be accounted for by examining the matrix formed by crossing the list of parts of the common environment against itself, taking care to include environmental transportation processes and to exclude cells which are outside the current research scope. This may result in further revision of the latest list of factors and list of relationships among factors. An additional check may now be made on the whole set of relationships, for consistency and closure.

If for some reason the set of factors and relationships is not to be transformed into a computer simulation programme, the interaction flow-charts, data-tables, and other material generated in the process of this research will nevertheless be of considerable use. It will have improved one's mental model of the Mediterranean for such purposes as the design of new institutions, broad forecasts, deciding about further research and data collections, etc. Other parts of the Mediterranean system could be reached by a similar procedure with different emphasis. Instead of focussing attention on oil, tourism, and ecology one would then use other frameworks such as the ones suggested below. These different foci could be pursued by different teams in various Mediterranean universities and institutes. A working-group would eventually integrate the various lists of factors, interactions, and other data obtained from each project into a single model. Depending on the stage of evolution of Mediterranean regional institutions at that time, this body of data could then be examined for policy implications. (Chadwick, 1971).

I *tourism/oil/environment*

(a) economy, demography, intervention
(b) tourism
(c) oil
(d) ecology, land/sea

II *fishing*

(a) economy, demography, intervention
(b) fishing, catch data
(c) fisheries management
(d) pollution/marine ecology
(e) mariculture

III *raw materials*

(a) protein, cereals
(b) fisheries
(c) oil
(d) markets, imports, exports

IV *sociocultural milieu*

(a) emigration
(b) labour, conditions
(c) ideology: economic
(d) religious, social values
(e) prevalent cultural images
(f) power, decision-makers
(g) poverty, development

VII *conflict*

(a) historical conflicts: frontiers
(b) trade
(c) arms sales; military presence
(d) ideology, allies, neutrality

VIII *towns*

(a) coastal industries; riverbank
(b) pollution; anti-pollution
(c) urban traffic, land-use
(d) environmental links
(e) quality of life
(f) town-country interaction

The procedure suggested above will now be illustrated by means of examples of the contents of some of the cells. For this we shall choose the matrix of Fig. 5, which deals with intersectoral processes of interaction within a generalised single subregion ('local'), within the Oil/Tourism/Ecology framework already mentioned. It is clear that the examples are still fragmentary and do not constitute a case-study either for any subregion or for any issue.

In practice, the material appears in the cells as rough notes: facts, ideas, references jotted down while reading or while analysing other cells. Transcribed, then, from these will be a list of factors ordered by sector and kept in the appropriate diagonal cell for easy reference. Each cell will also contain several 'processes': each process is a link between certain factors as causes and certain factors as effects (one factor may be in both categories in a situation of reciprocal influence). Processes may be ordered, for easy retrievability, by the main cause sector and the main effect sector. The processes and factors must be presented in such a way as

(a) to facilitate rapid investigation of all the influences on a given factor; and all the other factors influenced by the given factor.

(b) to preserve the convenience of sectoral reference afforded by the matrix format.

(c) to reconcile the requirement of prose description with the requirement of consistent reference to each factor and at the same time facilitating scanning of long lists.

These criteria become increasingly important as the information accumulates especially when one has to start pruning the model of unnecessary factors, draw flow-charts and find feedback loops, and convert each process into algebra. With these considerations in mind, each factor, even if not yet conceptually narrowed or if there is no hope of direct quantification, is assigned a reference designation:

$$F \text{ (factor no., sector, subregion)}$$

Similarly, each process is assigned the label:

$$P\left(\begin{matrix}\text{process} & \text{cause} & \text{effect} & \text{cause} & \text{effect} \\ \text{number}\,' & \text{sector}' & \text{sector}' & \text{subregion}' & \text{subregion}\end{matrix}\right)$$

Thus an example of a factor might be F (5, D6, –), indicating the 5th listed factor in the sector D6 (Oil), the hyphen indicating an unspecified general subregion. A process whereby some factors mainly in sector D6 influence others which lie mainly in sector D4 might be referred to as P (17, D6, D4), or P (17, D6, D4, –, –). Such $P(\ldots)$ designations are used in the records to head a small extract of descriptive prose which portrays a process. In this extract the names of the factors, whenever they occur, are accompanied by an appropriate $F(\ldots)$ label on the right-hand margin, in one of two columns according to whether it plays an independent (cause) or a dependent (effect) role in the particular process being

considered. Such extracts refer to the current subregion as 'local' and to any other as 'foreign'; and they are classified as suggested in Fig. 5, according to ordered pairs of sectors, i.e. according to 'cells'.

LOCAL INTERSECTORAL INTERACTIONS

CELL (D5, D6)
TOURISM on *OIL*
D5 D6

Processes of Interaction: Preliminary verbal description	*Factors Designation* Causes	Effects
P(1,D5,D6,–,–)		
Average length,	F(1,D5,–)	
and number of annual trips	F(2,D5,–)	
by local airlines determine		
the consumption of airliner fuel		F(1,D6,–)
attributable to local subregion.		
(Possible complicating factors:		
political airspace limitations;		
part-ownership of airline.)		
P(2,D5,D6,–,–)		
The number of visiting tourists,	F(3,D5,–)	
the average length of stay,	F(4,D5,–)	
taxi-hiring propensity,	F(5,D5,–)	
self-drive car hire propensity,	F(6,D5,–)	
public transport use,	F(7,D5,–)	
affect automobile fuel consumption		F(2,D6,–)
in local subregion attributable to		
tourism.		
P(3,D5,D6,–,–)		
Cooking-fuel oil in restaurants and hotels,	F(8,D5,–)	
oil-content of petrochemicals purchased by visiting tourists,	F(9,D5,–)	
etc.		
affect the oil consumption locally		F(2,D6,–)
attributable to tourism.		

P(4,D5,D6,–,–)
Oil-fuel consumption (attrib. to tourism) F(2,D6,–)
occurs in the building and maintenance of superstructure and infrastructure of the tourist industry. F(10,D5,–)

P(5,D5,D6,–,–)
The probability and F(11,D5,–)
extent F(12,D5,–)
of possible damage to tourist establishments and amenities (beaches, shoreline allottments, attractiveness of coastal waters for swimming and water-sports, etc.) helps determine the F(13,D5,–)
extent of justification for primary F(3,D6,–)
and for secondary F(4,D6,–)
treatment of effluent from any local refineries (number and effluent capacity and load of loc. refineries.) F(5,D6,–)
(This process involves sectors D1, D2, D3.)

CELL (D5, D7)
TOURISM on *LAND ECOL.*
D5 D7

Processes of Interaction: Preliminary verbal description	*Factors Designation* Causes	Effects
P(1,D5,D7,– Intensity of tourism, both local and incoming foreign,	F(14,D5,–)	
and types of activities on land, rivers, etc.	F(15,D5,–)	
cause occupation,		F(1,D7,–)
disturbance, and		F(2,D7,–)
littering		F(3,D7,–)
of natural recreational areas.		
P(2,D5,D7,–,–) The extent to which tourist development takes place in nonindustrialised areas of the		

local subregion (e.g. a correlation coefficient between areas of new tourist developments and areas with not-already-developed land-use.) This may be developed into an index of 'dispersion' of economic development, by tourism.	F(16,D5,–) F(4,D7,–)	F(1,D2,–)
Desirability of geographical dispersion of development through tourism (West, 1976, p. 10)		F(5,D7,–)
is affected by type of tourist development (incl. capacity),	F(17,D5,–)	
by intensity of tourism	F(14,D5,–)	
by certain characteristics of local population and culture,	F(?,D3,–)	
and social and governmental values and policies, and	F(?,D1,–)	
by the cost of the developments.	F(18,D5,–)	
P(3,D5,D7,–,–) The overlap (a correlation coefficient?) between areas of new tourist developments and	F(16,D5,–)	
areas of agricultural land-use	F(7,D7,–)	
will contribute to a *conflict* or trade-off between tourism and agricultural land-use, which may be expressible in terms of tourist developments' opportunity-costs (in whole economy).		F(8,D7,–) F(?,D5,–)
P(4,D5,D7,–,–) Tourism projects in underdeveloped parts of the subregion	F(16,D5,–) F(4,D7,–)	
may include the upgrading of the infrastructure facilities thus producing a benefit for the local population. (West 1976, p. 10)		F(1,D2,–)
P(5,D5,D7,–,–) Tourism developments on the coastline	F(21,D5,–)	

may reduce the amount of coastal vegetation along the shores of Mediterranean mainland and islands.		F(9,D7,–)
P(6,D5,D7,–,–)		
The intensity of tourism,	F(14,D5,–)	
governmental and	F(?,D1,–)	
entrepreneurial policy	F(?,D1,–)	
and perceived cost-benefits of	F(?,D2,–)	
tourism (in whole economy) results in investment for new projects and, after a		F(22,D5,–)
building *delay*,	F(20,D5,–)	
various forms of land-use:		
hotels and apartments		F(10,D7)
recreation areas (urb. & suburb.)		F(11,D7,–)
parks, nature reserves, etc.		F(12,D7,–)
roads		F(13,D7,–)
airport area		F(14,D7,–)
marine parks		F(1,D8,–)
P(7,D5,D7,–,–)		
Over-demand for sewage services arising out of overseas and local		F(3,D2,–)
tourism	F(14,D5,–)	
may be a problem.		
This	F(3,D2,–)	
may result in more sewage effluent		F(4,D2,–)
that is improperly treated,		F(5,D2,–)
remaining in local waterways.		F(15,D7,–)

CELL (D5,D8)

TOURISM on *MARINE ECOL.*

D5 D8

Processes of Interaction: Preliminary Verbal Description	*Factors Designation* Causes	Effects
P(1,D5,D8,–,–)		
The intensity of tourism,	F(14,D5,–)	
the tourists' beach-using		

propensity, F(23,D5,–)
the desirability of the
beaches (coastal areas without
sand etc. are included) F(16,D7,–)
the tourists' littering propen-
sity, F(24,D5,–)
contribute to the
total beach use, F(17,D7,–)
the extent of litter on the
beaches, F(18,D7,–)
and in the coastal sea. F(1,D8,–)

P(2,D5,D8,–,–)
The process P(7,D5,D7) results
also in untreated sewage discharge F(2,D8,–)
into the coastal sea through
various forms of outlet arrange
ments. An increase also F(4,D2,–)
results in normal treated waste. F(3,D8,–)
Both forms of waste include
ammoniacal nitrogen compounds, F(4,D8,–)
nitrates F(5,D8,–)
nitrates F(6,D8,–)
other nitrogen compounds F(7,D8,–)
some of which are insoluble. F(8,D8,–)
Various stages of oxidation initially
characterise this effluent: the
rate of biological oxidation F(9,D8,–)
in the water causes a consumption
of dissolved oxygen, creating a
biological oxygen demand (B.O.D.) F(10,D8,–)
reducing the actual oxygen content F(11,D8,–)
of the water and increasing its
general bionutrient level. F(12,D8,–)
(The process P(7,D5,D7) involves
tourist numbers in hotels, etc., F(14,D5,–)
and over-demand of sewage servi- F(3,D2,–)
ces.)

P(3,D5,D8,–,–)
The available recreation servi-
ces, F(25,D5,–)
the attractiveness of recreation
locations in the coastal sea, F(13,D8,–)

the intensity of tourism,	F(14,D5,–)	
and the various propensities of		
the tourists,	F(26,D5,–)	
determine the intensity of		
various forms of space-use		
in the coastal sea:		
swimming		F(13,D8,–)
boating,		F(14,D8,–)
sailing		F(15,D8,–)
water-skiing		
diving;		F(16,D8,–)
some of these activities repre-		F(17,D9,–)
senting a *conflict* in marine		
space-use with the fishing indus-		
try's shallow-water fishing, esp-		F(5,D2,–)
ecially in N. Africa and Mediterra-		
nean generally. (Unesco, 1975)		

In the diagonal cells, none of which has been shown in the above example of three cells, lie the processes which are mostly internal to the sector concerned. Thus, the cell (D5,D5), which lies of the main diagonal of the matrix in Fig. 5, would contain descriptions of processes which show the interdependence of the 'tourism' factors mentioned in all the other cells. It is helpful for this reason to include in every such diagonal cell a list of such sectoral factors with their labels.

As suggested earlier, such raw material, while continually revised, yields information about feedback loops or closed paths of influence. Thus, for example, the more tourists there are in one place, if the crowding limit or carrying capacity is approached, the less attractive will that destination be, causing the rate of arrivals to level off. Also, some of the effects of tourist developments, such as damage to the coastal flora, might after a certain delay, kill the goose that laid the golden egg. More complex paths will involve not one or two but several sectors in a feedback loop. An examination of these loops and of their polarity (whether they are positive and deviation-amplifying or negative and goal-seeking) is an essential part of the analysis of complex systems.

This kind of research serves among other things to indicate which are the weak spots where data is required for a more complete and exact understanding of the system. For smaller projects, such research serves to give the broad view of the system which one needs before pruning away the less significant processes and

variables in search of the essential minimum. The next step is to examine available data sources, while attempting to quantify the factors and the processes. One of the problems in this area has been, and still is, that of assigning numerical quantities, particularly equivalent dollar costs, to such things as recreational quality changes, and also to such things as changes in esthetic values of landscapes. An account of the seriousness of this problem and of some attempts to solve it is given in Ramsay, 1972. This includes, among other things, an account of an approximate measure of recreational demand (boating-days, swimming-days, and fishing-days) derived for various levels of the oxygen content of the water of large lakes. This was done by combining such techniques as: semiquantization of variables on two-point integer scales (0 or 1 to represent two possible states, or existence and non-existence, of a characteristic); expert water-quality ratings on 5-point scale; correlation of the latter with chemical measurements; and multiple regression of public survey data on participation in boating and swimming, this variable being considered as dependent on several socio-economic and locational variables of the type just mentioned. The resulting multiple regression equation, which was intended for use in broader cost-benefit models, had $R^2 = 0.280$, and thus explained only 28% of the behaviour of 'swimming participation' by the public. This is however much better than nothing, and such techniques can often be improved. Non-statistical techniques, such as those involving creative extrapolation and forecasting, are also possible. When quantification is attempted, rough error or confidence estimates should be included wherever possible, since such data will show how much justification there is in developing the results in certain directions, such as cost-benefit analyses of various key parameters, or systems simulation and forecasting.

In the Mediterranean area there is both wide scope and pressing need for such research: because of the extent of regional problems and of the probable imminence of institutional changes requiring information tools. Joint interdisciplinary and integrative systems research about the Mediterranean region could also serve as a method for stimulating co-operation among Mediterranean universities and other institutes.

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