Combining a Method for Evaluating the Contribution of Human Activities to the Sustainable Development of Islands and a Priority-setting Method to Examine If and Where can Aquaculture Established in a Given Island

Chatziefstathiou Michael [1, 3] and **Spilanis Ioannis** [2]

1. President, Panhellenic Society of Technologists Ichthyologists (PA.S.T.I.), Piraeus, Hellas.
2. Assistant Professor, University of Aegean, Department of Environment, Laboratory for Local & Insular Development
3. PhD Candidate, University of the Aegean, Department of Environment, Laboratory for Local & Insular Development, University Hill, GR-81100, Mitilini, Hellas (GR). E-mail: mhatzi@env.aegean.gr

Abstract

Sustainable development seems to be a universal goal to modern societies, exceeding the economic development objectives. Also, the priority-setting task always involves trade-offs due to political, social, cultural, financial, legal and technological constraints. The outcome of a priority-setting task can be the ranking or scoring of each option's performance, or it can be the allocation of a fixed resource, often money, amongst the alternative options. However, the measurement of economic development and regional comparisons through GDP are effective, but the sustainability evaluation and comparisons have limited application.

There is a need for practically applicable models, guidelines, and analytical frameworks that can help decision makers and companies to resolve trade-offs and direct limited financial resources towards projects or regions where the expected returns are greatest. On the other hand, objective of an aquaculture development plan for an island region must be to provide a sound basis for the development of a new all year round human activity - like aquaculture industry - on the island, while at the same time to conserve the unique environment of this island for the present and future generations.

The islands, in spite of their wide diversity, are all confronted to a greater or lesser extent with similar problems, which ought to be studied in a special and separate way from the territories of the mainland: isolation and remoteness, limited natural and human resources, fragile environments, difficulties in terms of competitiveness and economic development. Human activities in island regions involve a consideration of great potentials in conjunction with significant constraints in various development aspects.

The Laboratory for Local & Insular Development has elaborated a method to estimate the economic, social and ecological status of the islands and the driving forces that originate them. In the evaluation for the role of different human activities we use variables and indicators that measure their impact on the area and the factors that affect these impacts, as well as their contribution to the sustainable development. Hereon we present how the application of this method, combined with a priority-setting method, helps us to examine if marine aquaculture in a given island contributes to its sustainable development, and, after that, where is the best site to establish its installations to minimise possible conflicts between marine aquaculture and existing and future users of the island.

Keywords: aquaculture, sustainable development, islands, conflicts

1. Introduction

The islands of the European Union face similar problems: isolation, remoteness, limited natural and human resources, problems in economic development and fragile environments [Eurisles, 2002]. According to EuroStat, and for planning reasons, an island is a area surrounded by water, inhabited at least by 50 people, not linked to mainland by a permanent device (bridge etc), no less than 1 Km from mainland, with no capital of Member State.

At the same time, as world population is growing and the levels of wild capture fisheries decrease, with an increasing recognition of seafood as part of a healthy diet and a growing affluence among the populations of some key export markets, an enormous opportunity for islands is reflected in further development of the marine aquaculture industry, mainly towards the production of premium species [Frankic A and Hershner C., 2001].

This presentation constitutes part of a larger scale research, which aims at examining the problems raised in relation to the efforts made for marine aquaculture to be established in islands [Klaoudatos S, Conides A and Chatziefstathiou M., 1996b], and examines whether marine aquaculture in a given island contributes to its sustainable development, and, after that, where is the best site to establish its installations trying to minimise possible conflicts between marine aquaculture and existing and future users of the island.

2. Sustainable Development and Island Regions

Data concerning the exact situation of the island regions and in particular regarding the nature, extent and evolution of their problems, are often incomplete, out of date or insufficient. Problems of size, remoteness, status and isolation need to be analysed using conceptual tools [Eurisles, 1997].

Apart from the different existing definitions of what constitutes an “island”, it seems more suitable to refer to the more holistic notion of insularity. The concept of insularity extends beyond the simple geographic boundaries and includes biogeographical, sociological and economic concepts. Insularity can be defined, in the field of social sciences, as “being the result of a conjunction between a geographical condition and the reactions of political, social, economic and cultural peripheralisation” [Hache J.D., 1987].

According to many researchers [Braudel F., 1972] [Baldacchino G., 2004], the sea is just one of a series of media which act as frontiers or barriers to transfers. In other words, literal islands, surrounded by water, are only one sort of insular situation in the physical world. Horden and Purcell [Horden P, Purcell N., 2000] refer to virtual islands and quasi-insular regions, while Braudel [Braudel F., 1972] refers to islands not surrounded by sea, while they emphasise the notion of pen-insula.

Conceptually, diagnosis is known: scarce resources leading to rarity and lack of diversification; small local market leading to exposure to outside; single-production exports; natural risks; lack of economies of scale and economies of agglomeration for both the private sector and the public infrastructures; reduced competition and disadvantage of dispersion.

It is very difficult to measure the island specificities linked to the rarity of their natural resources, their ecological fragility, transport overcasts, and degree of dependence on market economy. Certain comparative advantages have enabled islands to develop certain social or economic mechanisms favourable to their populations.

The specific characteristics of the islands arise from the above set of factors, and the "island phenomenon" is defined by a combination of these factors. Insularity may not in itself be the determining factor in explaining the economic development [Eurisles, 1997]. However, all these characteristics affect the economic development of islands. Combined effects of size, dependence and distance implied different consequences (e.g. turn of priority from island's self-sufficiency on food, to mass agricultural production) in combination with the different economic systems determine the type of development of each island. Undoubtedly, the ruling economic system of 20th century based on the mass and homogeneous production has marginalized the islands.

The term "sustainable development" together with the socio-economic development imply the informed and conscientious management of natural resources, which have been exploited or utilized by humans, so that these resources may be capable of exploitation over time. Whatever the various definitions may be [Chatziefstathiou M, Charalambous A, Makris G and Kargioti I., 2003], they are all translated into "**development that respects environment, enabling harmonious economic and social progress**". Sustainable development of **islands** calls for sustainable management that implies **both** the consideration of environmental content in activities, such as industry, tourism and leisure, fishery, agriculture, aquaculture, **as well as** management of coastal resources, ecosystems, water quality etc [UNEP-MAP, 2002].

Small islands, especially, required an agro-ecological approach in the pursuit of sustainable development [Brooks K.M., 2002]. Human activities like fisheries, agriculture, forestry, have provided for centuries the main source of livelihood for the population of the many problematic nowadays islands. Their sustainable management is fundamental for the future. Work in small islands involves the consideration of a series of constraints and potentials in various aspects of development:

- Economic issues: narrow resources, isolation from markets, vulnerability to international markets, erosion of trade arrangements, high level of external aid, net food importers, dominance of tourism and public sector.
- Environmental issues: vulnerability to natural hazards, degradation and over-exploitation of natural resources, rich biodiversity, loss of traditional agricultural systems.
- Social issues: limited variety of dietary intakes and nutritional problems, institutional "brain drain", scarcity of skilled manpower and weak institutional capacities.

Due to increasing human population pressure, changing socio-economic structures, exploitation of natural resources and variable environmental conditions, islands need an interdisciplinary, integrated management strategy founded on values that will enable long-term sustainability. In the Mediterranean region, tourism is the largest industry. Uncontrolled development and thoughtless use of nature has disturbed this region's resources. In this area degraded coastal zone has been the focus of many international organizations trying to find solutions to the problems created by mass tourism.

The disenchanted tourist is moving toward pristine islands to capture what used to be on the main land. It is only a matter of time until tourism will also ruin the pristine islands [Frankic A and Lynch M., 1996]. Tourism and its development in Greek islands during recent decades have stopped their economic and demographic decline. However the conventional tourist model, based on sun, sea and sand (**3S**) seems to have failed to promote their sustainability due to the decreasing economic benefits for host communities and the continuous growth of environmental pressures. The latest trend in Greece and elsewhere is a shift from mass tourism to environmentally friendly and sustainable forms of tourism, and also an interest for promotion of human activities related to the primary sector of economy (rural development) [Spilanis I. & Vayanni H., 2004] [Chatziefstathiou M, Spilanis I & Charalambous A., 2005].

Sustainability strategies should be established and supported within the context of natural resources limitations and of socio-cultural constraints. The management objective is to develop "limits on acceptable change" to assess stress in the natural, social, and economic environment [Frankic A and Lynch M., 1996].

3. Measuring Sustainable Development of Island Regions

The sustainability analysis calls for the consensual setting of a "band of equilibrium" for a list of key indicators making it possible to evaluate the sustainability of the present situation in the region in question, and to determine what is desirable and what is unacceptable. The projection of these indicators also makes it possible to evaluate the region's sustainable development levels and thus its future sustainability.

As part of our research, we will attempt to develop suitable indicators as a tool to estimate the contribution of aquaculture, and compare different islands and level of development that can be applied to each one. In achieving this, we will take into account the economic, social and environmental aspects of aquaculture and the limitations derived from the island status. After that a case study will be followed, based on this method and series of indicators [Chatziefstathiou M and Spilanis I., 2004].

Our research aim is to define the main factors that maximise the benefits and minimise the cost, helping us to create a simple method that can promote the eligible activity for each area, and followed by the proper policy may contribute to the sustainable development of each specific island.

Although many times it is common practice to develop a single indicator of sustainable development, this logic has not been adopted here. Reasons for this are that the adopted definition of sustainable development indicates that we must have a clear picture of the progress in each one of the three dimensions separately. Moreover, when a single index is developed, the policy makers cannot make clear suggestions. In order to do this the overall number of factors must be taken into consideration. This does not mean that the different factors of each one of the three dimensions of sustainability (economy, environment and society) must be appointed the same weight factor.

For example, in the case of tourism, it can be assumed in general that every action plan for a region, which seeks to move away from the model of conventional tourism and apply new forms of tourism, is welcome, since it contributes to the selected area’s sustainability. On the other hand, it is considered as too utopian to believe that the development of economically sustainable tourism activities will have absolutely no environmental impact [Spilanis I and Vayanni H., 2004]. Changing the conventional tourism model - or any model of an already established intensive human activity with no consideration of social and environmental impact - is not an easy task because it is based on strong market mechanisms.

The evaluation of each human activity can be based on two criteria: first, the performance per productive unit, which relates to the added value and the employment created per unit, as well as the consumption of water and energy and the production of wastes per unit; and, secondly, the scale of the activity compared to the carrying capacity of the host area for all the human activities happening there.

Even if the performance per unit is improved, every area has its own environmental, social and economic limits that cannot be surpassed [Spilanis I and Vayanni H., 2004].

In this work, following the method developed by the Laboratory of Local and Insular Development [Spilanis I, Kizos T, Kondili J, Koulouri M, Vakoufaris H., 2005], sustainable development is not envisaged as an 'end in itself' target, but as a *continuous process* of development, which leads simultaneously to the improvement of economic, social and environmental goals adopted by *each society*.

This approach is shown in Fig. 1.

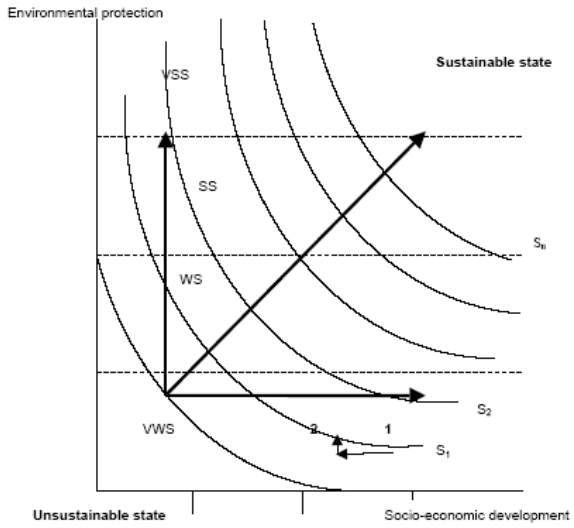

Figure 1: Sustainable development as a continuous process of development

For the purposes of the method that we develop, following the UNEP's DPSR analysis (Driving force, Pressure, State, Response) (Fig. 2), the evaluation of any activity (like tourism or aquaculture) has been based on two criteria.

First, the activity performance per production unit, which relates to the added value and the employment created at the area per production unit (overnight staying for tourism, kg for cheese, tonne for farmed fish), as well as the consumption of water and energy and the production of wastes per unit; and second, the scale of the examined activity compared to the carrying capacity of the host area.

The horizontal axe represents the socio-economic development while the vertical axe the environmental protection. The curves S_1, S_2, Sn are indifference curves that represent different levels of sustainability.

The dotted horizontal lines indicate the different levels of environmental protection: Very Weak Sustainability (VWS), Weak Sustainability (WS), Strong Sustainability (SS), and Very Strong Sustainability (VSS).

Examining the sustainability on the curve S_1, the movement from point 1 to point 2 indicates a lowering of socio-economic development and an increase of environmental protection.

According to this, we consider as sustainable any form of activity that, in a given region, alters the conventional produced service or product to have more economically profitable and / or more environmentally friendly result.

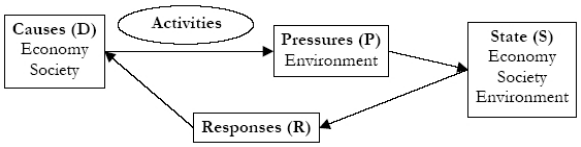

Figure 2: Framework of analysis

Adoption of the DPSR framework helps us to separate the **causes** (driving forces, the human activities examined) from the **pressures** (at the region, from these activities) and parameters that describe the **state** of an area.

The focus of the DPSR framework was broadened to include not only environmental but also economic and social issues, and led to the classification of factors – used also in the international literature – into the four categories of the DPSR framework.

4. Case study selection: Aquaculture

It is generally recognised that the most known commercial fish species are at, or near, full exploitation and internationally many have exceeded the maximum sustainable yield and are already at or beyond the point of commercial extinction [Chatziefstathiou M, Charalambous A, Makris G and Kargioti I. 2003]. The world's increasing demand for seafood can only be met through aquaculture and it is expected to dominate global fish supplies by 2030, with less than half the fish consumed coming from capture fisheries [Friends of Europe, 2003].

Aquaculture is recognised as playing an increasing role in addition of choice of quality fisheries products for the consumers; nevertheless without increasing fishing pressure, together with the provision of an alternative employment in the areas dependent on fisheries. Aquaculture has an important role to play in coastal (rural) development and in reversing decline in fishing communities and EU Members encouraged by the Commission to adapt funding opportunities for aquaculture underline the role of women and encourage the use of European Social Fund programmes to improve opportunities in aquaculture.

As a result of its rapid growth in recent years, aquaculture is facing a number of challenges in terms of market and environment. Its future will depend on its ability to become economically viable and its capacity to respond to environmental constraints. Increase in its production must come from diversification in new species and from making her more environmentally friendly [Chatziefstathiou M, Charalambous A, Makris G and Kargioti I., 2003] [Chatziefstathiou M., 2000] [Burbridge P, Hendrick V, Roth and E, Rosenthal H., 2001].

The establishment of fish farms at islands is based – by economic way of speaking – on a comparative advantage: the farms, mainly in floating cages, use two recourses that are in a great abundance at the islands, (clean) sea and easy access from the (remote) beaches.

Therefore, even if today there are some difficulties, i.e., island isolation, distance from the main fish markets and the increased transport cost, the investors will continue to show an interest in establishing fish farms at the island regions [Klaoudatos S, Conides A and Chatziefstathiou M., 1997].

There is, however, a question about whether and how this human activity can contribute to the islands sustainable development. Some aspects regarding the fast aquaculture development require more particular attention. Concerns relate to environment, health and animal welfare issues, as well as potential conflicts with fisheries and recreational activities.

Even if aquaculture constitutes a dynamic sector of primary production, it also faces significant structural problems. Analysis of profitability ratios [Pnevmatikatou A, Batzios Ch and Katos A., 2002] has led to findings, which could be the basis for enhanced decision-making. Statistical analysis of the profitability ratios was performed, placing the farms in order of size, on the basis of financial criteria, such as solvency ratios, etc. Evaluation of estimates has revealed that sea bream and sea bass sector are exceptionally heterogeneous from the aspect of managerial effectiveness. The level of "total assets turnover ratio" consists to a significant criterion of size.

Detailed field study at two Greek islands [Katranidis S, Nitsi E and Vakrou A., 2003] analysed impacts on employment, income, and area production, and has highlighted the great importance of this form of development to the local economy. Estimation of regional multipliers indicates that an increase in aquaculture production would increase the income of the prefecture by between 0.28 and 0.68 units. Although the area has a strong primary sector, this does not result in any significant exports, as the majority of the production of the island is consumed locally.

On the contrary, the contribution of marine aquaculture exports to the total exports of the prefecture is greater than the total exports from the rest of its primary sector. Also, the aquaculture sector has inputs amounting to 35% and exports to 95% of the production value. Increase of production value by l unit leads to increase of regional product by 0.68 units and to an increase in the income generated from aquaculture by 0.65 units.

The specific analysis has demonstrated that the impact of aquaculture farms is significant for the islands, not only due to the localized effects of jobs creation, but also because of their significance for the islands, as the main activity generating income and exports. There are certain noticeable advantages in local employment and income terms that call for the support of marine aquaculture development in both islands.

Thus, if this angle is considered, it helps to reduce or even avoid social conflicts. Outlining the contributions to the sustainability of local economy can assist in alleviating opposition to aquaculture development by local communities. The very significant benefit from reducing the pressure to the global fish stocks are not easily and clearly visible to local communities and as it appears does not concern them at all, even if their economy depends on fisheries.

In this point we must notice that the main effect from aquaculture waste is the increase of the concentration of nutrients at natural water column and the potential increase of plankton populations [Brooks KM., 2002] [Katranidis S, Nitsi E and Vakrou A., 2003].

Also that wastewater from marine aquaculture differs in a very substantially manner from the municipal wastewater (sewage). Sewage contains high volumes of organic matter and harmful for human microbial load, in contradiction with aquaculture wastewaters that their composition is similar to natural waters. Source of nutrients mainly are fish feeds remains and water-soluble fish excreta, well known to the marine bacteria [Charalambous A, Chatziefstathiou M and Makris G. 2002].

Recent results [Katranidis S, Nitsi E and Vakrou A., 2003] indicate that fish farming zones examined under the present levels of production and at the present scheme of site selection procedures do not impose significant changes on macrofaunal community attributes. Even if fish farming releases considerable amounts of nutrients in the water column it seems that these do not affect the productivity in a way that could negatively affect the benthic environment beyond the zone at the immediate vicinity of the farms [Karakassis I, Papadopoulou KN, Apostolaki E & Koutsoubas D., 2005].

These consequences have differential effects, depending on the physical and socio-economic characteristics of each island, having as a result different behaviour and reactions from the local inhabitants and different developing routes for the fish farm companies.

There is also a social and cultural dimension to public acceptance of aquaculture development and people's perceptions of the environment and the condition of the coastline can account for a large proportion of the problems, according to the study [Katranidis S, Nitsi E and Vakrou A., 2003] focused on the identification of potential conflicts and the analysis of impacts occurring from aquaculture farms on the islands of Cephallonia and Ithaki, in western Greece.

Greek society and especially small isolated communities are faced with numerous cultural and other obstacles when pursuing collective decisions and attitudes to resolve environmental and sustainability problems, such as preference of individualistic methods when solving one's own problem, short-sightedness, scientific fuzziness, confusion of priorities.

Scientific knowledge and data are not always at hand and experts' views may be manipulated to serve political or economic interests. It may also happen that non-scientific, biased, interest-oriented or intuitive views are well disguised as scientific ones [Sapountzaki K and Wassenhoven L., 2005].

In such a framework, and as the rules of communicative process equate the scientific information with the prejudiced information, stakeholders find it very easy to ignore the scientific aspects of complex environmental and development problems. Under these circumstances and because each one of the stakeholders usually carries prejudiced knowledge, the scientific information, collective knowledge and consensus become useless.

Several researchers [Sapountzaki K and Wassenhoven L., 2005] state that the local societies usually pursue individualized, instinctive solution and practices. The motive behind this is that the resource constraints introduce a requirement for priority setting, thus selecting policies or projects where the financial resources will be directed, always involves trade-offs due to political, legal, social, cultural, economic and scientific constraints.

Marine aquaculture (or Mariculture) is a new competitor for the same limited resources and this antagonism should be judged on the basis of the efficiency of resource utilize as well as the environmental compatibility. Common criteria should be employed in the evaluation of all potential users, and thorough economic evaluation, including socio-economic and environmental costs and benefits, is a good way to achieve this.

Many activist environmental groups currently consider marine aquaculture to require extremely tight regulations in comparison with the other human investments in the same regions. However, such expressed views are not based on realistic estimates of relative costs / benefits (including environmental costs) associated with mariculture and other forms of development [Burbridge P, Hendrick V, Roth and E, Rosenthal H. 2001].

For example, the relation between aquaculture and tourism is controversial. The coexistence of both activities can lead to positive and negative impacts. In terms of negative impacts, marine aquaculture can pose constraints on the use of the shoreline for tourism-related activities, such as bathing, fishing, and boating.

It can also be a source of water pollution due to nutrients released into the water and to noise pollution, decrease a coastal area's biodiversity or degrade the landscape.

But there are also strong positive effects, such as the increase of fish stocks for fishermen as a result of marine aquaculture, good quality of fish for tourists and restaurants, and occasionally serving as a tourist attraction [Katranidis S, Nitsi E and Vakrou A., 2003], by including activities such as visits for fishing included in alternative tourism packages.

5. Minimising Conflicts between Aquaculture and Other Users

Resources constraint is one of the major causes for conflicts between existing and future users of an area, especialy in the island regions, where the elligible areas for new development are limited. For that reasons it is need to introduce a requirement for priority setting, which can be defined as the task of selecting a subset of issues, policies or projects towards which limited resources will be directed.

The priority-setting task always involves trade-offs due to political, social, cultural, financial, legal and technological constraints. The outcome of a priority-setting task can be the ranking or scoring of each option's performance, or it can be the allocation of a fixed resource, often money, amongst the alternative options.

The ATS model [Hajkowicz S and McDonald G., 2006] emerged from the need to ensure environmental priority-setting decisions were analytically rigorous and well structured. Its primarily role is to guide the selection and weighting of evaluative criteria.

Under the ATS model (Fig. 3) environmental problems related to highly valued assets (asset value) causing a large amount of damage (threat) but easily fixed (solvability) would be considered high priority. Investment in these problems is likely to deliver greater public benefit and have the minimum conflicts.

Conversely, problem acting on low value asset, with low severity and hard or expensive to solve would be low priority.

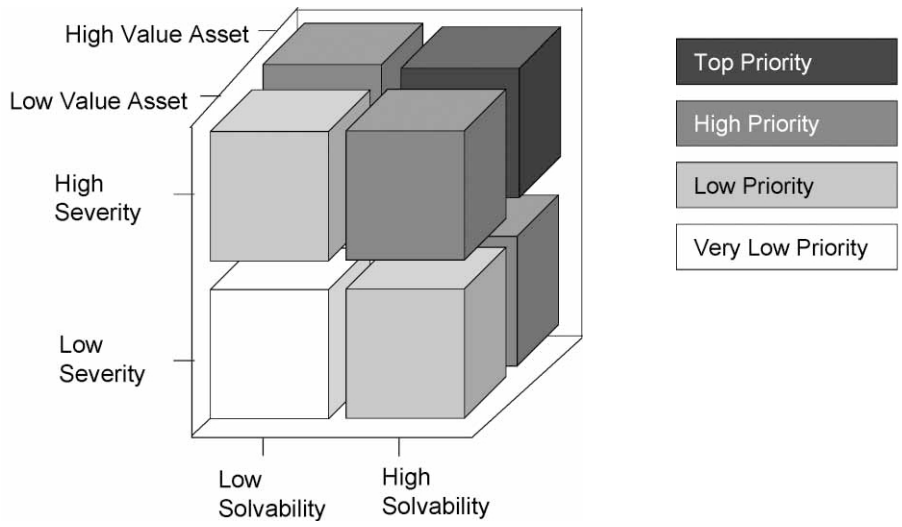

Figure 3. The assets, threats and solvability (ATS) model

In our work we **broadened** and the ATS model to include not only environmental but also economic and social issues. Adopting the principles of ATS involves a rational approach to decision-making as opposed to an informal, unstructured or an intuitive approach.

The main contribution of this enhanced ATS model is to provide a robust analytical structure for decision-making. This structure sets a solid foundation for handling intangible issues requiring human judgement, which arise in the majority of significant priority-setting decisions. Major advantage of this model is the structure of the methodology introduced to the debate. Using ATS people could debate threat and asset issues and provide insights. Group clarification about the nature of different threats can lead to revisions.

The ATS model adopted because shares much in common with the pressure state response (PSR) framework, which is near to our method for measuring sustainability that is based to the DPSR framework. When faced with a complex assemblage of data, managers can apply the model we develop to help them select criteria for priority setting in a structured manner.

The quality of judgements about which projects, programmes or locations receive investment, and therefore which do not, will partly dictate the success or failure of policy. Another key factor determining success is the ability to implement the projects once selected. There is a need for practically applicable models, guidelines and analytical frameworks that can help decision makers resolve trade-offs and direct limited resources towards projects or regions where the expected returns are greatest.

The question of validating the ATS framework is problematical because there is no 'correct' answer to a priority-setting problem acting as a benchmark. Priorities are dependent on people's preferences [Hajkowicz S and McDonald G., 2006]. Feedback from decision makers can provide some insights but invariably carries bias. The decision procedure may have worked well, but if it did not select a decision maker's un-stated preferences it may be evaluated poorly.

It is likely that different notions of good decision procedure apply to different fields of decision-making, e.g. environmental, financial, economic and social. Without attempting to synthesize all that has been written on procedural rationality, we can identify some basic principles [Hajkowicz S and McDonald G., 2006]. A sound decision procedure should be:

a. Transparent. The reasons behind a particular decision should be clear to all interested parties. This will require explicit statement of assumptions, data and value preferences. A transparent decision procedure also satisfies requirements for auditing.
b. Repeatable. With the same assumptions, input data and value preferences the decision procedure should always yield an identical, or at least similar, result regardless of who applies it and when.
c. Involve comprehensive use of information. It should not be possible to identify additional information that could have been used at low cost and within reasonable time frames. The information refers not only to scientific data, but also input from community and stakeholders.
d. Consistent with the decision maker's preferences. The decision maker will invariably have preferences for some decision objectives over others. The procedure should reflect these preferences in its final selection of options. In other words, the procedure should satisfy axioms of a rational decision (e.g. transitive preferences etc.).
e. Consistent with social, moral and legal obligations. Decisions are never made in a policy, legal or social vacuum. There will generally exist social norms, standards and legal obligations that set additional constraints around the selection of actions.

Meeting these requirements does not necessarily guarantee a 'good' decision outcome. However, there would be an expectation that decisions performing well on these criteria will typically lead to better outcomes than others. Analysts developing decision procedures can use the requirements of procedural rationality to design appropriate policy frameworks and tools and to minimise conflicts and local negative reactions.

The initial ATS model has been developed with this purpose – it aims to improve procedural rationality. If applied appropriately, the structured approach to setting priorities in enhanced ATS model will improve the procedural rationality of decisions.

6. Discussion

The sustainability level of an area is higher if its development is not dependent on a single activity: the economic risk then is lower and the stress on some of the natural resources of the area is less important [UNEP-MAP, 2002]. Aquaculture on islands is a great example of how to become sustainable and how not to. The islands represent 'small globes' and can show more easily how the process of globalisation and self-sustainability can be implemented.

In this approach aquaculture can contribute by increasing household food supply and improving nutrition, increasing household economy through diversification of income and food sources; to strengthen economies by increasing the employment and reducing the food prices; improving water resource and nutrient management at community level; preserving the aquatic biodiversity through re-stocking and recovering of protected species. Also, it can help to reduce pressure on fishery resources, improve natural habitats, stimulate in local level to the research and technological development, and, finally, increase education and environmental awareness in small communities.

The main question asked hereon, whether the mariculture can improve the sustainability level of an island region, is only a part of the above actions and refers directly and exclusively to the island ecosystems. Key to achieving a successful sustainable development in the island regions is the choice of appropriate management systems and structures in combination with the deployment of more integrated marine policies [Chatziefstathiou M. 2000].

In this case, all the area's stakeholders must *commonly agree* upon the weight of the different factors chosen. Participatory processes constitute appropriate practices for this purpose. Having reached such an agreement, the monitoring and evaluation processes can become more suitable and more effective.

The sustainability goals on islands exist and are predetermined and quantitative. Monitoring practices will ensure that in the course of the programs implemented, activities will not lead to the deviation from the targets. At the end of the policy period, evaluation practices will determine whether the overall state of an area improved.

This tool can also help to determine the appropriate and inappropriate sites for projects in areas that considered suitable for development, facilitate decision making processes for spatial planning, incorporating socio-economic and environmental assessment elements, to promote sustainable development of the islands.

7. Future steps to conclude the research

The system of measurement has to be simple, relying on published or easily accessible data. Our research will continue with the elaboration of measurement methods for complex indicators (e.g. marine aquaculture inputs and outputs) and completion of data collection (some problems encountered are inadequate local cooperation, dispersion of data sources on different islands and no data in some cases). As the techniques evolve there will be a need to balance theoretical correctness against practical needs of programme managers who typically make decisions with incomplete data, limited access to analytical skills and tight time frames.

Final steps will be the evaluation of existing data quality, the calculation and aggregation of indicators, and the assessment of the different sustainability level. As far as the assessment is concerned, three indexes, one for each dimension of sustainability, will be formed [Chatziefstathiou M, Spilanis I and Vayanni H., 2006]. The exact method for aggregation has not been determined yet, but this will be done after the completion of data collection.

8. Acknowledgements

The described method for measuring sustainability at the islands is based on an initial work funded by the Program ISTOS (Innovation for sustainable tourism and services in the South Aegean), assigned to the Laboratory of Local & Insular Development, aimed at construction of a practical tool for the maintenance and the improvement of sustainability at a local level.

9. References

Baldacchino G., 2004. The coming of age of island studies, Tijdschrift voor economische en sociale geographie 95 (3), 272-283; 2004

Braudel F., 1972. The Mediterranean and the Mediterranean world in the age of Phillip II, Vol. I. London and New York; 1972

Brooks KM., 2002. Assessing the Risks: A comparison between the environmental impacts of aquaculture and traditional agriculture. Northern Aquaculture, January 2002

Burbridge P, Hendrick V, Roth and E, Rosenthal H., 2001. Social and economic policy issues relevant to marine aquaculture. J. Appl. Ichthyol. 17 (2001), 194 - 206

Charalambous A, Chatziefstathiou M and Makris G., 2002. Treatment and Disposal of Waste Water from Aquaculture Installation. 1st International Congress on Aquaculture, Fisheries Technology & Environmental Management. 8 - 10 June 2002, ECEP Expo, Athens, Greece

Chatziefstathiou M and Spilanis I., 2004. Aquacultures' Contribution at Sustainable Development of Island Regions. AquaMedit 2004. 2nd International Congress on Aquaculture, Fisheries Technology & Environmental Management. 18 - 19 June 2004, Evgenidion Foundation, Athens, Greece

Chatziefstathiou M, Charalambous A, Makris G and Kargioti I., 2003. Sustainable development: Is the use of fish meal in aquaculture compatible with the effort for sustainable management of Marine Biological Resources? 11th Panhellenic Congress of Ichthyologists, Preveza, Greece, April, 2003

Chatziefstathiou M, Spilanis I and Charalambous A., 2005. Sustainable Development of Island Regions and the role of Aquaculture. EcoForum: 1st International Conference for Environmental Management, Policy and Technology. 28 - 30 June 2005, Nicosia, Cyprus, EU (Invited Speakers)

Chatziefstathiou M, Spilanis I and Vayanni H., 2006. Developing a Method to Evaluate the Contribution of Different Human Activities to the Sustainable Development of Islands: Case Study on Marine Aquaculture. Sustainable Management and Development of Mountainous & Island Areas. International Conference. 29/9/2006 – 1/10/2006, Naxos.

Chatziefstathiou M., 2000. Environmental Management Systems (E.M.S.) and Marine Aquaculture. 6th Panhellenic Symposium of Oceanography & Fishery, Chios, 5/2000

Eurisles, 1997. Statistical Indicators of Regional Disparities Caused by Insularity and Ultra-Peripherality. European Islands System of Links and Exchanges (Eurisles). Ed. Eurisles, 10/1997

Eurisles, 2002. Off the coast of Europe. European construction and the problem of the islands. European Islands System of Links and Exchanges (Eurisles). Study undertaken by Eurisles on the Initiative of the Islands Commision of CPMR. 2002

Frankic A and Hershner C., 2001. Seafood recipes: balancing aquaculture development with coastal planning. In: International workshop on 'Aquaculture and Its Role in Integrated Coastal Zone Management'. European Aquaculture Society, 19–21 April, Oostende, Belgium; 2001

Frankic A and Hershner C., 2003. Sustainable aquaculture: developing the promise of aquaculture. Aquaculture International 517–530, 2003

Frankic A and Lynch M., 1996. ECOSTAR, A Program For Identifying Ecotourism Activities That Support Sustainable Development In Coastal Regions. World Ecotourism Conference in Honolulu, 6/1996

Friends of Europe, 2003. Is fish-farming a long-term answer to the fisheries crisis? FoE, The European Trialogue, Summary of Debates. February 3, 2003

Hache JD., 1987. The island question: Problems & prospects, Ekistics, 323/324, 88-92; 1987

Hajkowicz S and McDonald G., 2006. The Assets, Threats and Solvability (ATS) Model for Setting Environmental Priorities. Journal of Environmental Policy & Planning, Vol. 8, No. 1, March 2006, 87–102

Horden P, Purcell N., 2000. The corrupting sea: a study of Mediterranean history. Blackwell Publishers, Oxford; 2000

Karakassis I, Papadopoulou KN, Apostolaki E & Koutsoubas D., 2005. Mesoscale effects of fish farming zones on macrobenthic communities in the Aegean Sea. The X European Ecological Congress (Eureco '05), 11/2005, Kusadasi, Aydin, Turkey

Katranidis S, Nitsi E and Vakrou A., 2003. Social Acceptability of Aquaculture Development in Coastal Areas: The Case of two Greek Islands. Coastal Management 31:37-53 2003

Klaoudatos S, Conides A and Chatziefstathiou M., 1996a. Assessment of the Impact of the floating cage culture systems on the Marine Environment. 3rd Panhellenic Convention on Environmental Protection, August 1996, Chania, Greece

Klaoudatos S, Conides A and Chatziefstathiou M., 1996b. Environmental Impact Assessment (E.I.A.) studies in floating cage culture systems in Greece. «Littoral '96» 3rd International Conference of the European Coastal Association for Science & Technology, Portsmouth, England, 16 - 19 September 1996

Klaoudatos S, Conides A and Chatziefstathiou M., 1997. Study of the coastal and marine ecosystem of Kalloni gulf, Lesvos Island, NE Aegean Sea and organisation of a permanent remote sensing system for environmental monitoring. Final Report. Greek National Centre for Marine Research, Institute of Marine Biological Resources, Aquaculture Department; 1997

Pnevmatikatou A, Batzios Ch and Katos A., 2002. Comparative investigation of profitability ratios of the sea bream and sea bass Greek aquaculture sector. 1st International Congress on Aquaculture, Fisheries Technology & Environmental Management. 8 - 10 June 2002, ECEP Expo, Athens, Greece

Sapountzaki K and Wassenhoven L., 2005. Consensus building and sustainability: Some lessons from an adverse local experience in Greece. Environment, Development and Sustainability, (2005) 7: 433–452

Spilanis I and Vayanni H., 2004. Sustainable tourism: utopia or necessity? The role of new forms of tourism in the Aegean Islands – Greece. In Bramwell B. (ed), Costal mass tourism. Diversification and sustainable development in S.Europe, Channel View Publications, p.269-291; 2004

Spilanis I, Kizos T, Kondili J, Koulouri M, Vakoufaris H., 2005. Sustainability measurement in islands: The case of South Aegean islands, Greece. International Conference on Biodiversity Conservation and Sustainable Development in Mountain Areas of Europe. 20-24 September, Ioannina, 2005

UNEP, MAP, 2002. Indicators for Sustainable Development in the Mediterranean Coastal Regions. Plan Bleu, Final report. Plan Bleu pour l'Environnement et le Développement en Méditerranée. Regional Activity Centre. Sophia Antipolis, December 2002