

Sustainable Development of Island Regions and the role of Aquaculture

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Summary

Purpose of this paper is to shortly present the general principles of sustainable development, the problems arising from island status, the definition of aquaculture and its role to global food production. Our research's main goal is to examine if aquaculture actually contributes to sustainable development of island regions and to propose a simple and easy to use tool for choosing the best available aquaculture type for each island.

The islands in spite of their wide diversity, are all confronted to a greater or lesser extent with similar problems: isolation and remoteness, limited natural and human resources, difficulties in terms of competitiveness and economic development, and fragile environments. Work in island regions involves consideration of potentials and constraints in various aspects of development, e.g. in Mediterranean, tourism is the largest industry, but its thoughtless use of nature and uncontrolled development has taken a toll of this region's resources.

At the same time, there is a continuous increase on world demand for seafood and it is estimated that aquaculture will dominate global fish supplies by 2030, with less than half the fish consumed coming from capture fisheries. Objective of an aquaculture development plan for island regions is to provide a sound basis for developing a new aquaculture industry in the islands, while at the same time conserving the unique environment of the islands for present and future generations, and minimising conflict between aquaculture and existing and future users of the islands.

The Laboratory for Local & Island's Development elaborated a specific methodology for the estimation of tourism contribution to sustainable development of islands. In our research for the role of aquaculture we assess other evaluation methods for aquaculture's sustainability, and we proceed with the adaptation of the previous mentioned methodology. Next step will be a field research, aiming to estimate today's role of aquaculture and the actions needed for this activity to really contribute to the sustainable development of the island regions.

Keywords: aquaculture, sustainable development, island regions, islands, conflicts

Βιώσιμη Ανάπτυξη των Νησιωτικών Περιοχών και ο Ρόλος των Υδατοκαλλιεργειών

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Περίληψη

Σκοπός αυτού του κειμένου είναι να παρουσιάσει συνοπτικά τις γενικές αρχές της βιώσιμης ανάπτυξης, τα προβλήματα που εγείρονται από τα ιδιαίτερα χαρακτηριστικά των νησιών, τον ρόλο της υδατοκαλλιέργειας στην παγκόσμια παραγωγή τροφίμων και την μέχρι σήμερα έρευνα μας. Κύριος σκοπός της έρευνας μας είναι να εξετάσουμε εάν οι υδατοκαλλιέργειες πραγματικά συνεισφέρουν στην βιώσιμη ανάπτυξη των νησιωτικών περιοχών κι έπειτα να προτείνουμε ένα απλό και εύκολο στην χρήση εργαλείο για την επιλογή του καλύτερου διαθέσιμου τύπου υδατοκαλλιέργειας για κάθε νησί.

Τα νησιά παρά την μεγάλη ποικιλία τους, αντιμετωπίζουν σε μεγαλύτερη ή μικρότερη έκταση παρόμοια προβλήματα: είναι απομονωμένα και απομακρυσμένα, έχουν περιορισμένους φυσικούς και ανθρώπινους πόρους, εμφανίζουν δυσκολίες σε επίπεδο ανταγωνιστικότητας και οικονομικής ανάπτυξης και έχουν ευαίσθητα περιβάλλοντα. Οι εργασίες σε νησιωτικές περιοχές απαιτούν προεργασία και σκέψη αναφορικά με τις δυνατότητες και περιορισμούς των διαφόρων αναπτυξιακών δράσεων, π.χ. στην περιοχή της Μεσογείου ο τουρισμός είναι η μεγαλύτερη βιομηχανία, όμως η ανεξέλεγκτη ανάπτυξη του και η αλόγιστη χρήση της φύσης έχει οδηγήσει σε υποβάθμιση του συνόλου των πόρων της ευρύτερης περιοχής.

Ταυτόχρονα αυξάνονται συνεχώς οι απαιτήσεις παγκοσμίως για πιο πολλά αλιεύματα και εκτιμάται ότι οι υδατοκαλλιέργειες θα κυριαρχήσουν στον παγκόσμιο εφοδιασμό και μέχρι το 2030 λιγότερα από τα μισά αλιεύματα που θα καταναλώνονται θα προέρχονται από την συλλεκτική αλιεία. Σκοπός ενός ολοκληρωμένου σχεδίου ανάπτυξης υδατοκαλλιεργειών στις νησιωτικές περιοχές είναι να παρέχει μία καλά μελετημένη πρόταση για την ανάπτυξη των υδατοκαλλιεργειών, ενώ θα φροντίζει για την διατήρηση του μοναδικού περιβάλλοντος τους για τις παρούσες και μελλοντικές γενεές και θα ελαχιστοποιεί τις συγκρούσεις μεταξύ των υδατοκαλλιεργειών και των υφισταμένων και μελλοντικών χρηστών των νησιών.

Το Εργαστήριο Τοπικής και Νησιωτικής Ανάπτυξης προχώρησε στην δημιουργία ιδιαίτερης μεθοδολογίας για την εκτίμηση της συνεισφοράς του τουρισμού στην βιώσιμη ανάπτυξη των νησιών. Στην έρευνα μας για τον ρόλο των υδατοκαλλιεργειών επεξεργαστήκαμε και άλλες μεθόδους για την εκτίμηση της βιωσιμότητας των υδατοκαλλιεργειών και προχωράμε με την προσαρμογή της ανωτέρω μεθοδολογίας. Επόμενο βήμα είναι η έρευνα στο πεδίο, με χρήση της τροποποιημένης μεθοδολογίας, και σκοπό την εκτίμηση του ρόλου που διαδραματίζουν σήμερα οι υδατοκαλλιέργειες και των ενεργειών που απαιτούνται ώστε η συγκεκριμένη δραστηριότητα να συμβάλει πραγματικά στην βιώσιμη ανάπτυξη των νησιωτικών περιοχών.

Λέξεις Κλειδιά: υδατοκαλλιέργειες, βιώσιμη ανάπτυξη, νησιωτικές περιοχές, συγκρούσεις

Introduction

Everybody is agreed: an island is a territory surrounded by water. However, that's as far as the consensus goes and the problems start as soon as we try to understand and compare the island regions between them and – something even more difficult – to understand their difference from the mainland, even from the coastal areas.

The islands of the European Union, in spite of their wide diversity, are all confronted to a greater or lesser extent with the same problems: isolation and remoteness, limited natural and human resources, difficulties in terms of competitiveness and economic development, and fragile environments (Eurisles, 2002).

According to the European Union (EuroStat, "Portrait of the islands"), an island is a territory surrounded by water:

1. inhabited by more than 50 permanent people,
2. not linked to the mainland by a permanent device (bridge, tunnel...),
3. distant by at least 1 Km from the mainland,
4. with no capital of an EU member state

Following that rule, e.g. Cyprus - even if it is the third largest island in the Mediterranean Sea, with an area of 9,251 km², and with a totally exposed coastline of 778 km long – it is not an island !! This also apply e.g. for Malta, Ireland, Britain, Sjaelland in Denmark, Evia and Lefkas in Greece, etc.

The need for such a rule is that we must can apply specific island policies to the regions that really need them, like small islands or an archipelago, and not to the Island States of Europe or some islands that have minimise the "Island Phenomenon" (that will be explained in another part of this paper). This does not mean that they have solved their problems, but mainly that for these areas other development policies will deploy.

At the same time, against the background of a growing world population, static levels of wild capture fisheries, an increasing recognition of seafood as part of a healthy diet and growing affluence among the populations of some key export markets, further development of the aquaculture industry, mainly towards the production of premium species, represents an enormous opportunity for islands (Frankic et al., 2001).

Purpose of this paper is to shortly present the general principles of sustainable development, the problems arising from island status, the definition of aquaculture, its role to global food production, and its future development.

Starting from the hypothesis that further economic development of island regions is needed (Eurisles, 2000), that their sustainable management remains crucial for their future (Eurisles, 2002), and that one way to do that is to continue develop marine aquaculture among other activities (European Environmental Agency, 2002), we will try to present the major issues and dilemmas arising today from this use.

This presentation is a small part of a research trying to define the major problems raised from aquaculture's continues tend to establish in islands (Klaoudatos et al., 1996), and to examine if aquaculture as an activity contributes to the sustainable development of island regions, and after that, having in mind similar problems and the technical and managerial solutions applied in different regions (Australian Ministry of Agriculture, Forestry and Fisheries, 2000), to propose a simple and easy to use tool for choosing the best available aquaculture type for each island to promote its sustainable development.

The Laboratory for Local & Island's Development has elaborated a specific methodology for the estimation of tourism contribution to sustainable development of islands and there is a short presentation of this methodology. In our research, for the role of aquaculture, we start from the quest for similar problems around the world and the assessment of the methods for evaluation of aquaculture's sustainability, and now we proceed with the adaptation of the previous mentioned methodology, that will be followed by field research, aiming to estimate today's role of aquaculture and the actions needed for this activity to really contribute to the sustainable development of the island regions.

Sustainable Development and Island Regions

Sustainability refers to the ability of a society, ecosystem, or any such on-going system to continue functioning into the indefinite future without being forced into decline through exhaustion or overloading of key resources on which that system depends. In general, the concept of sustainable development is simple and important, but translating it into specific standards or criteria is difficult, often subjective and misused. Sustainability has three basic sectors: the environment, the society and the economy (Chatziefstathiou et al., 2002).

The term "**sustainable development**" implies the informed, conscientious management of the natural resources that are exploited or utilized by humans so that these resources may be capable of exploitation over time. Sustainable development has undergone numerous definitions, the first of which was formulated in the 1987 Brundtland report, i.e. "sustainable development is a mode of development that meets the needs of current generations without compromising the capacity of future generations to meet theirs".

Whatever the various definitions are, they are all practically translated to "**development that respects the environment, enabling harmonious economic and social progress**". The inclusion of environment in development policies is a constant in most of these definitions.

The sustainable development of island regions calls for sustainable management that implies **both** the taking into account of environmental components in human activities such as aquaculture and fishing, agriculture, transports, industry, tourism and leisure-activities, etc., **and** the management of coastal resources, ecosystems, water quality etc (UNEP, 2002).

Small islands required a special agro-ecological approach in the pursuit of sustainable development (Brooks, 2002). Agriculture, fisheries and forestry have provided for centuries the main source of livelihood for the population of the islands. Their sustainable management remains crucial for the future. Work in small islands involves consideration of potentials and constraints in the various aspects of development, including:

- Economic issues: narrow resource base, isolation from major markets, vulnerability to volatile international markets, erosion of preferential trade arrangements, high external debt, high level of foreign aid and remittances, net food importing countries, difficulties in conforming to sanitary regulations, importance of tourism and dominance of public sector.
- Ecological issues: rich marine and terrestrial biodiversity, vulnerability to natural hazards, harsh competition for scarce natural resources, particularly fresh water, degradation of coastal habitats, loss of traditional agricultural systems and over-exploitation of forest and coastal resources.
- Social issues: high population growth and mobility, limited variety of dietary intakes and nutritional problems, institutional "brain drain", scarcity of skilled manpower and weak institutional capacities.

Considering increasing human population pressure, changing socio-economic structures, fluctuating environmental conditions and on-going exploitation of natural resources, coastal areas and island regions need an integrated, interdisciplinary management strategy founded on principles that will enable long-term sustainable development.

Technical solutions to most problems in the environment do exist (Chatziefstathiou et al., 1997). Unfortunately science and technology are often pushed aside from short-term social or economic considerations, having a few good examples (e.g., ecotourism is an area in which there is a commonality of social, economic, scientific and technical considerations).

In the Mediterranean region, tourism is the largest industry. Uncontrolled development and thoughtless use of nature has taken a toll of this region's resources and resource base. In this same area the degraded coastal zone is the focus of many international conventions and organizations trying to find solutions to the problems created by mass tourism. The disenchanted tourist is moving toward pristine islands to capture what use to be on the main land. It is matter of time until tourism ruins the pristine islands.

Tourism is a major activity also in Greek islands and Cyprus. Its development during recent decades has stopped the economic and demographic decline of these areas. Nevertheless in the Greek islands the conventional tourist model, based on sun, sea and sand (**3S**) has failed to promote sustainability due to the limited economic benefits for host communities and the continuous growing 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 to re-establishing activities of the primary sector of economy. Policies to change tourism and production patterns in the Greek islands will need to take into consideration their unique characteristics, their existing realities, and to be based on the exploitation of the local natural and cultural resources in order to develop new forms of sustainable activities (Vagianni et al., 2004, Chatziefstathiou et al. 2004).

Sustainability strategies should be established and supported within the context of natural resources limitations and socio-cultural constraints. A region's cultural heritage and natural resources should define the tourist carrying capacity of the region. The management objective is to develop "limits on acceptable change" to assess stress in both the natural and the social and economic environment (Frankic et al., 1996).

Analysing the Island Phenomenon

Data concerning the exact situation of the island regions and in particular the nature, extent and evolution of their problems, is often incomplete, out of date or insufficient. Problems of size, remoteness, status and isolation crop up immediately and these problems need to be analysed using conceptual tools (Eurisles, 1997).

Conceptually, the diagnosis is known:

- scarce resources leading to rarity and lack of diversification,
- small local market leading to exposure to the outside,
- single-production exports,
- natural risks whose consequences are aggravated by size factors,
- lack of economies of scale for both the private sector and public infrastructures,
- the perverse effects of monopolies and reduced competition,
- the disadvantage of dispersion for the archipelagos.

It is very difficult to measure island specificities linked to the rarity of their natural resources, their ecological fragility, transport overcosts, 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).

These characteristics affect the economic development of the island regions. Effects of size, dependence and distance imply different consequences, as do historical periods or economic systems, but, overall, they determine the type of economic development of a territory.

One fact which always holds true is that the islands are **smaller** than the mainland areas. While this seems to be stating the obvious, it nevertheless leads to a very simple first level of reasoning. Because of its endemism to the islands, smallness implies **rarity**.

While this rarity manifests itself in various ways, it is measured mainly by the scarcity and paucity of resources (raw materials, infrastructures, human potentialities, etc.). In order to **manage these rare resources**, the island economies adopt a specific management system. This is based on the **need to have access to a major network of exchange with the outside**. From colonialism to today's trade deficits, this phenomenon is a constant factor of the economic history of all the island economies.

Rarity and openness to the outside are factors that lead to a high degree of dependence, due to a single-product export activity and a high level of imports. This dependence, which is due to the weakness of the domestic economy and the dominant role of «external» trade, is significantly aggravated if, in addition, **the island is remote and located far from markets**.

Even from a linguistic point of view, island comes from the Latin word *insula* and later the Italian word *isola*, from the verb *isolare* – isolate. For the realistic presentation of insularity a new indicator developed from the Laboratory of Local & Island's Development of University of Aegean, that presents not the real (geographical) distance between the island and the mainland (the main harbour or the capital city), but the virtual (calculated on the base of the time needed) distance. This indicator helps us to compare the island regions with mainland and present the problems arising from insularity in a more easy to understand base.

That regionality and insularity indicator (DP) is the division of the virtual distance to the real distance. The virtual distance is estimated by taking into account the real distance on a digital map, the time needed for the trip by sea, the waiting time to get into and get out from the ship, the frequency of weekly ship arrivals to the island (directly from the main harbour, or through an other island), and interruptions in traffic linked to climatic conditions and industrial action, like strikes and heavy harbour works (Spilanis et al., 2002).

When we compare real distance (RD) and virtual distance (VD) in some Greek islands we will see that for Serifos RD is 119 km and VD is 594 km, for Lesbos RD is 285 km and VD 665.28 km, for Symi RD is 398 km and VD 1871.10 km, for Chalki RD is 399 km and VD is 3320.46 km !! That means significant cost for transportation, much more isolation and reduced competitiveness for the islands that we initially thought, especially if we take in mind the time needed for a city to city travel by car (e.g. from Athens to Chalkis, about 90 km, it is less than 45 minutes) and the speed of railway and track transportation in mainland Europe.

We must proceed to the evaluation of the costs of insularity because it is essential for the understanding of the economic evolution of an island. Successful operation of an economic system depends on the degree of control and capacities to adjust to the external prerequisites, which develop in the process of sharing-out of the resources.

Effectiveness of this process depends on the degree of initiative and consistency of private investors, suitability and extent of government intervention, transparency of the market and level of information on economic realities and on its use to facilitate economic forecasts.

The foreseeable consequences of the reduction in public spending (on which they depend to a large extent), the threats to their single-sector activities (agriculture, fisheries, tourism, etc.) or their demographic (young/old) or territorial (coast/inland) imbalances, place them in a very unfavourable situation, e.g with regard to the EU enlargement, etc (Eurisles, 2002).

Definition of Aquaculture

The Food and Agricultural Organisation (FAO) of the United Nations defines aquaculture as "Farming of aquatic organisms including fish, molluscs, crustaceans and plants, with some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated".

Fish farming typically involves the enclosure of fish in a secure system under conditions in which they can thrive (Klaoudatos et al., 1995). Aquaculture is usually dependent on natural ecosystems (Klaoudatos et al., 1997). It can impact freshwater supplies, modify coastal habitats, compete with the commercial wild catch, or through escape, introduce non-indigenous organisms and disease to new environments (Frankic et al., 2003).

Aquaculture is a complex industry where success for each individual company, each sector and the industry as a whole is dependent on a multitude of inter-related factors that are constantly changing (European Commission, 2002). Successful aquaculture development involves a breadth of activities, mainly in the coastal zone, spanning areas such as engineering, environmental management, land and marine planning, transport, education, marketing and research and development (Stead et al., 2002).

General facts related to aquaculture activities

- Aquaculture is a global, inevitable and a fast growing industry.
- Part of our past and present history, and its needed in our future.
- There are environmental, social, and economic problems.
- 'Use conflicts' are everyday scenarios in the coastal areas.
- Growing consumer demand for environmentally responsible products (e.g., the Marine Fisheries Conservation Programme, ecolabeling, ISO 14000, EMAS, etc).
- Continuing development of indicators for environmental, social and economic aspects of aquaculture activities, to monitor and evaluate impacts and sustainability of its nature.
- Aquaculture on islands is a great example of how to become sustainable and show how not to. They represent 'small globes' and show how the process of globalisation and self-sustainability can be implemented.

It is generally recognised that 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 et al., 2002).

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).

Trends on Aquaculture Development

As a result of its rapid growth in recent years, the European Aquaculture industry is facing a number of challenges in terms of market and of the environment. Its future will depend on its ability to become economically self-sufficient and its capacity to respond to environmental constraints. Increase in production must come mainly from diversification in new species and from making aquaculture more environmentally friendly.

The real problem of capture fisheries is that there are too many vessels for the available fish. Consequence of this imbalance is that for an increasing number of fish stocks, the quantity of mature fish is below the minimum estimated by scientists as necessary to provide a high probability of sustainability (precautionary level of stock biomass). If current trends continue many stocks will collapse in the short term, damaging the fishing industry as biological collapse would lead to the economic decline of the fishing fleet.

At the contrary, aquaculture is widely recognised as playing today a continues increasing important role in the extension of the choice of quality fisheries products for consumers, and nevertheless without increasing fishing pressure together with the provision of alternative employment in coastal areas dependent on fisheries.

Aquaculture has an important role to play in rural and coastal development and in reversing decline in coastal communities. EU Member States are encouraged by the EU Commission to adapt funding opportunities for aquaculture, underlines the role of women and encourages the use of European Social Fund programmes to improve opportunities in aquaculture.

The establishment of fish farms at islands is based – by economic way of speaking – to 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. So, even if there are today some difficulties, occurring mainly from their isolation, distance from the markets and the increased transport cost, the investors will continue to have interest on establishing fish farms at the islands.

There is, however, a question on if and how this activity contributes to the islands sustainable development. Some aspects regarding the development of aquaculture require particular attention. Concerns mainly relate to environment, health and animal welfare issues, as well as potential conflicts with fisheries and recreational activities in coastal areas.

To make the above more clear we can take as example our host island, Cyprus. Despite being one of the larger islands in the Mediterranean, the share of overall fishery production of Cyprus represents less than 0.3% of GDP. However fisheries sector plays a significant socio-economic role to this island state. Fisheries employ 1,350 people, the majority on a full-time basis (Eurostat; Member States' programming documents for structural assistance 2004-06).

Aquaculture production has steadily increased in recent years, with seabass / seabream as the main species, having 6 fish farms, 4 hatcheries, 1 tuna farm, 1 shrimp, and 7 trout plants. Fish farming has a major role producing today 3.500 tones and 15,000,000 fries (more than 70% of total annual fishery production and 70% of its value), with total value of 19.5 million Cypriot Pounds (about 33.3 million euros), and employing over 100 people in the fishfarming sector (Cypriot Ministry of Agriculture, Natural Resources and Environment, 2005).

The only culture system employed in Cyprus for the production of seabream, seabass and sharpsnout bream is the open sea cage culture system. The main reasons for adopting this culture system are the lack of protected bays in Cyprus, the high competition for the use of the coastal land and the fact that this culture system is considered as having the least impact on the environment.

Special mention must be done to the 7 smaller sites that produce around 100 tonnes of trout in the mountain areas of Cyprus. The 6 of them use normal land based (raceways) intensive systems, but the 7th use floating cages in an irrigation reservoir, at Evretos dam.

This last establishment is one of the most sustainable activities and well adjusted to the environment. Small lake, artificial, work as water tank for irrigation, hosting a floating fish farm the cold period of the year (at the Cypriot summer the temperature is very high for the trout), and ecotourist activities like angling and game fishing all year round, without one activity "conflicting" with the other.

To this Island State in addition to the other types of aquaculture, the Department of Fisheries and Marine Research is managing a number of inland waters (reservoirs) for angling. About 17 different freshwater fish species were introduced and acclimatized in the island providing good angling opportunities to locals and visitors in 22 reservoirs.

In 2004 were introduced by the Department of Fisheries & Marine Research 2,632 individual angling licenses at reservoirs, and 124 group licenses for 411 persons. At the Kalopanayiotis Fresh Water Aquaculture Research Station continued with success the production of trout fries for the private farms and for stocking of the reservoirs for angling (Cypriot Ministry of Agriculture, Natural Resources and Environment, 2005).

Targeting Sustainable Development of Island Regions

During recent years there has been considerable progress in both the acceptance of the need to manage the way in which humans interact with the environment, and the tools available to achieve such management. This trend is exemplified in the increasing promotion of the "ecosystem approach", where controls are human activities and the demands we make upon the environment, as opposed to managing ecological processes (Grant et al., 1997).

Ecosystems, although frequently described as "fragile" have remarkable powers of resiliency. As long as basic processes are not irretrievably damaged, ecosystems will continue to recycle and distribute energy, sustaining the resources upon which we rely. A healthy functioning ecosystem not only sustains itself, it can also sustain local human communities, economies and industry. We can work on the sustainable development of an area with an ecosystem approach. This holistic management method can be divided into six steps:

1. Vision and environmental goal-setting
2. Integrating policy
3. Assessment
4. Decision-making and spatial planning
5. Management tools
6. Strategy for management, including monitoring, enforcement, etc

The sustainability analysis then calls for the consensual setting of a "band of equilibrium" for the key indicators making it possible to judge the sustainability of the present situation in the region in question, and determine what is desirable and what is unacceptable. The projection of these indicators, based on the prospective of the studied system, then makes it possible to judge the future sustainability and thus the region's sustainable development level.

In our research we will try to develop a matrix of 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, taking in mind 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 series of indicators (Chatziefstathiou et al., 2004).

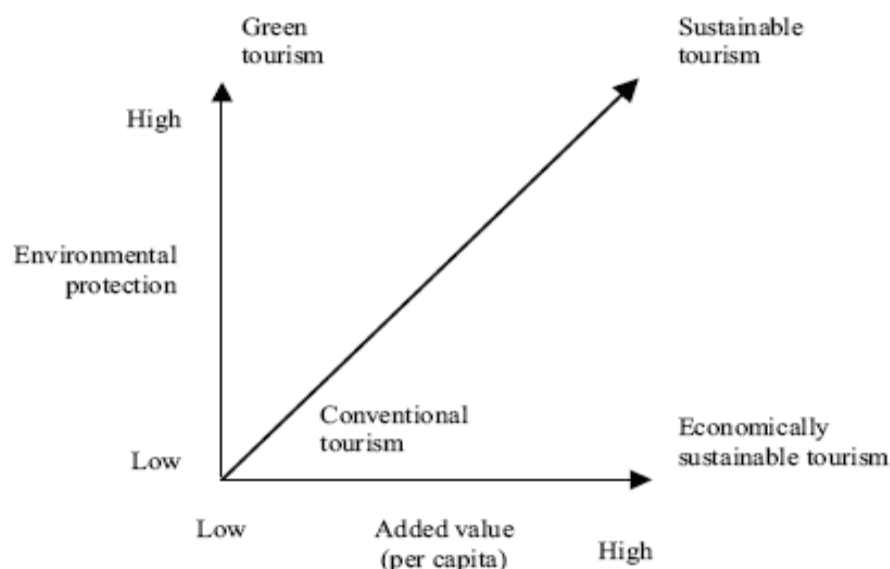
This tool we hope that can help to facilitate decision-making processes for spatial planning, incorporating socio-economic and ecological / environmental assessment elements. Perhaps in facilitating spatial planning decisions in its combined use with Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) it will help to determine appropriate and inappropriate sites for projects in areas considered suitable for development, and promote the sustainable development of the islands.

Taking tourism as an example, we can say in general that every action plan for a region that seeks to move away from conventional tourism and apply new forms of tourism is welcome, since it is contributing to the 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.

The following Figure (Vagianni et al, 2004) shows that this change in the pattern of tourism development has at least three dimensions:

- improvement in the environmental performance of enterprises in the tourism industry, and the imposition of limits to tourism growth (green tourism);
- the development of special interest forms of tourism through exploitation of the natural and cultural characteristics of the area, which means that the increase in added value per capita that is created remains within the host area (special interest tourism); and
- the development of forms of tourism that have a low environmental impact and at the same time contribute to the preservation and exploitation of cultural heritage and the maintenance of population and economic activities in remote areas (alternative tourism).

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. However, it is not impossible, especially if we consider the recent changes in global tourist preferences for vacations, the consumers' turn to quality products and services, their environmental awareness, and the development of environmentally friendly technologies.



According to this approach, we consider as sustainable any form of activity that, in a given area, alters the conventional activity product so that it is a more economically profitable and/or a more environmentally friendly product.

For the method we develop, following UNEP's DPSIR analysis (Driving force, Pressure, State, Impact, Response), the evaluation of any human activity (like tourism or aquaculture) can be based on two criteria: first, the activity performance per capita, which relates to the added value and the employment created per unit (tourist, farm, kgr, tonne), as well as the consumption of water and energy and the production of wastes per capita; and second, the scale of the examined activity compared to the carrying capacity of the host area. Even if the performance per capita is improved, every area has its own environmental, social and economic limits that cannot be surpassed.

Discussion

To have the desirable sustainable development level in island regions, it is better to have not a single-production and to base the islands' development on a more multidisciplinary approach, promoting the parallel deployment of different activities, like agriculture, tourism & leisure, and fisheries (UNEP, 2002). In this approach **aquaculture** can contribute by:

- Increase household food supply and improve nutrition.
- Increase household economy through diversification of income and food sources.
- Strengthen marginal economies by increasing employment and reducing food prices.
- Improve water resource and nutrient management at household or community levels.
- Preserve aquatic biodiversity through re-stocking, and recovering of protected species.
- Reduce pressure on fishery resources if done in a sustainable way.
- Improving / enhancing habitats.
- Stimulates research and technology development.
- Increase education and environmental awareness.

The questions asked on if aquaculture improves the sustainability of an island region is that only a part of the above actions refers directly and exclusively to the island ecosystems:

Concerning the **economy**, there are indirect and co-occurring consequences because of the demand that this activity cause (e.g. transportation, house renting, etc). In the contrary there are only a few cases of direct consequences because the specific investments mainly are coming from non-indigenous investors.

Concerning the **society** and especially the human recourses, the establishment of new working places, often for non specialised workers, is the major direct consequence, and the improvement of skills of the human recourses rarely have to do with the local inhabitants.

Finally, concerning the **environment**, the conflicts at beach uses and the risk for marine pollution from malpractice and mismanagement of the farms are the negative parameters that bring to a standstill the further development of fish farming. In the contrary the very significant benefit from reducing the pressure to the fish stocks are not clearly visible to the local communities, as it appear that does not concern them, even if they depend to 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, and that wastewater from aquaculture differs in a very substantially manner from 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 marine bacteria (Charalambous et al, 2002).

These consequences have differential effects, depending to the physical and socioeconomic 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.

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

Key to achieving a successful ecosystem approach in island regions is the development of appropriate management systems and structures in combination with integrated marine policies (Chatziefstathiou, 2000). Amongst the assessment tools available for use in order to achieve ecosystem management is the DPSIR analysis (Driving force, Pressure, State, Impact and Response) and the Strategic Environmental Assessment (SEA).

This can be defined as a formalised, systematic and comprehensive process of evaluating environmental impacts of a policy, plan or programme and its alternatives, including the preparation of a written report on the findings of the evaluation, using the findings in publicly accountable decision making (European Commission, 1999; European Commission, 2001; UNEP, 2002).

Conclusions and Recommendations

Ecosystem approach, indicators matrix, and DPSIR analysis (Driving force, Pressure, State, Impact and Response), have a key role to play in establishing those areas that may be environmentally sensitive or vulnerable to a variety of activities.

Depending on the type of the preferred development needed, some areas may be identified as sensitive or vulnerable for reasons other than their environmental characteristics. For instance a particular area may be important for fishing, aquaculture or tourism.

In the context of the preceding analysis of the current position of global, national and local aquaculture industry, a vision for the aquaculture industry in the islands could:

- Implement site selection and operation management practices based on the principles of ecologically sustainable development
- Work with local and indigenous communities to consider the social concerns and impact of aquaculture projects
- Ensure site selection processes consider the needs of all stakeholders but result in only economically viable sites being approved
- Develop into an industry serving local and international markets
- Commit to supplying only safe, high quality seafood to local and international markets
- Become professional and united with a global scope utilising the latest technologies and systems enabling members to earn a sustainable economic return on their investment
- Commit to an ongoing coordinated and collaborative research and development program aimed at continuous improvement in productivity and the development of environmentally sustainable technologies
- Continue to be characterised by a combination of small and large enterprises across multiple sectors bound by a joint commitment to build a clean, safe, sustainable and profitable industry supported by all inhabitants.

Aquaculture is a relatively new primary industry attempting to compete for resources against established industries and uses and probably controversy will accompany the new proposals.

Before any further major increase in the production, it is needed preparation and application of a policy for sustainable development of aquaculture, taking also in mind the needs of local and international markets.

The introduction of transparent planning, community consultation, reporting and objection processes, which meet public expectations on matters of public interest, will permit these discussions to be conducted in an atmosphere of trust (Fisheries Western Australia, 1997).

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