13. Conclusions

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In the foreword to FAO's flagship fisheries publication, *The State of World Fisheries and Aquaculture* (FAO, 2010b), there is an encouragement for "actors at all levels in the (fisheries and aquaculture) sector to make better use of the Internet, GIS, remote sensing and other technological advances to safeguard biodiversity and ensure a sustainable future for the sector"; it is broadly these factors that are addressed by this publication. Within the context of fisheries and aquaculture, it has been necessary to delve into a wide range of subsectors of these broad subjects, with the aim being to provide sufficient explanation that allows newcomers to GIS and remote sensing to readily comprehend what is being explained. This publication has enabled two previous FAO publications in fisheries and aquaculture GIS (Meaden and Kapetsky, 1991; Meaden and Do Chi, 1996) to be updated and considerably expanded, and it is to be hoped that this present publication can make a greater impact towards achieving sustainability for fisheries and aquaculture. Given the fact that EAA, EAF and marine spatial planning philosophies are now prevailing, it is necessary to think more broadly about the spatially based challenges to optimizing productivity from aquatic resources.

Within the marine spatial planning context, the European Union (European Commission, 2012) has recently identified six maritime functions that need to be integrated into marine spatial planning work: (i) maritime trade and transport; (ii) food, nutrition, health and ecosystems services; (iii) energy and raw materials; (iv) living, working and leisure in coastal regions and at sea; (v) coastal protection and nature development; and (vi) maritime monitoring and surveillance. It is likely that most future approaches to managing marine areas will be required to integrate all or most of these functions, and there is no doubt that GIS will be the technological basis on which this management will best function. Thus, the majority of challenges faced by these functional areas have a strong spatial component, and the use of GIS in the terrestrial domain has very adequately proved its functional capabilities and success. Additionally, examples have been provided in many places in the technical paper (e.g. Chapter 12) to show how GIS is now able to cope with the demands of most spatially based analyses in the challenging marine and aquaculture spheres.

However, the use of GIS and remote sensing in the fisheries and aquaculture fields still faces challenges associated with a knowledge of its capabilities and potential. At the present time, much of the fisheries- or aquaculture-based GIS output comes from the United States of America. The reasons for this are discussed and, given the overall resources it has, in many ways its dominance is not surprising. There are now indications that other countries are beginning to make headway with GIS work, especially in the aquaculture field. Most of the emerging GIS work is coming from the newly developing countries, especially those in East and South Asia, and because these areas face huge challenges in terms of population pressures, rapid rates of development, resource depletion, environmental degradation and competition for freshwater, then the incentives to utilize GIS will be constantly reinforced.

In countries where development is typically slower, although GIS studies for both fisheries and aquaculture are beginning to appear, little of this work is being published or promoted. In order to promote further GIS work, capacity-building measures need to be put in place allowing for the necessary infrastructure to be available to support enhanced GIS expertise and infrastructure. It is important that GIS capability is available to allow the multidisciplinary work associated with EAA and EAF to be pursued. For the least developed and more remote regions of the world, it may be some time before the widespread use of spatial technologies for fisheries and aquaculture development and management is achieved. However, except for a few core heartland areas, this remoteness, lack of population, lack of infrastructure and therefore lack of need mean that there will be little necessity for GIS capabilities.

The technical paper has placed considerable emphasis on how GIS might best be initiated. This includes a detailed chapter on the necessary stages for successful GIS implementation and another chapter on meeting GIS challenges. The conclusion chapter reinforces this by providing a table with the main answers to the question: “What is the way forward to successful GIS work?” The table differentiates between “establishing the existing situation” and “establishing an enabling capability”, and for both these areas the large number of suggested tasks is likely to initiate further questioning, research or investigation. The answers to many of the suggested tasks are, indeed, provided in this technical paper.

Wherever GIS or remote sensing methods are used, it is essential to remember that these applications work at a wide variety of scales. “Scales” can be viewed in two main contexts:

- Functional or operational scales relate to the size of a GIS operation in terms of investment and personnel employed. This varies between the “personal area network” and upwards to a “wide area network” scale. Because there is an easy ability to upgrade GIS systems when required, there is no need to begin GIS or remote sensing work at a sophisticated level.
- The geographic area covered by a project could vary from a localized scale to a world scale. The technical paper has provided examples or GIS case studies of all different scale areas. The ability to utilize GIS and remote sensing across different spatial scales is extremely useful in terms of data inputs to GIS, in terms of geographic cognition, and as a means of initiating collaborative working with neighbouring regions or countries.

The production of fish demanded in a more affluent world whose population is increasing by 80 million per year will pose a significant challenge. Meeting this challenge will certainly involve more stringent management and research, plus more complex forms of management that incorporate the broader concepts embedded in EAA, EAF and marine spatial planning. From the foregoing material in this technical paper, it is easy to envisage that the challenge will be met through the use of a suite of fisheries and/or aquaculture management tools, many of which will be linked to GIS because of its unique capacity of spatial analysis in conjunction with providing output in a range of easily comprehensible tables, maps and graphs. Because GIS has the capability to function at a huge variety of degrees of sophistication, it will be capable of being adopted almost universally. This is a technology that deserves to be enthusiastically promoted.