Coastal GIS at the turn of the century

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The final session of CoastGIS'99 took the form of a panel discussion, led and chaired by Darius Bartlett with contributions from Cindy Fowler, Roger Longhorn, Francois Cuq, Ron Furness and Lionel Loubersac. This was followed by a wider discussion of topics and issues raised, and included several interventions and commentaries from the floor. What follows is an edited transcript of the main points raised. While based on the verbal contributions from those named, editorial responsibility rests entirely with the session chair.

Darius Bartlett

Several interesting themes have come out of this conference, of which the most significant are probably those relating to coastal data. This topic has been addressed from a number of perspectives, and speakers have examined definitions of data: semantics, the design and use of data dictionaries, semiotics (that is the symbolism or meaning) of data; and also metadata and standards. Clearly these are all areas where there is much research activity, and where a lot of peoples' thinking is focused at the moment.

Related to the foregoing, a second important topic raised in many presentations has been the question of interoperability. This concept extends well beyond the technical dimension, and several other types of working together were discussed. For example we heard about institutional interoperability, that is helping institutions and people interact. This is a particularly important issue because, amidst our many and diverse professional or disciplinary interests, the one thing we all share is a concern with integrated coastal zone management. We may approach the issue from different starting points but, if we are to achieve this integration, somewhere along the line we have to find ways of getting all the different interest groups and stakeholders at the coast talking the same language. In other words, we are looking at, or for, interoperability at the level of the personnel involved, and also interoperability of the data we are collecting and using. A number of presentations and discussions addressed this last, particularly through examination of data exchange standards.

Wider contexts

These discussions and issues also mirror events taking place in the evolution of GIS generally. The whole field of GIS appears to be undergoing rapid change and evolution at the moment, both technologically and institutionally, though at least some of these changes almost suggest a return to earlier ways of doing things (in some cases, more efficiently in the light of technical improvements) rather than the introduction of radically new methods and techniques. For example, in the early days of Arc/Info and other pioneering proprietary systems, GIS software was often packaged as a "toolbox", with a wide array of utilities and functions provided with the system, but as separate modules, so that the user could select the specific tools required for a particular task and apply these as required. Later on came the more integrated approach, where all possible tools and functions were provided within a single package, with a common interface, whether they were required or not. This meant that users were inevitably stuck with the weaknesses of whichever GIS product they had selected, as well as its strengths. For coastal GIS this has been particularly relevant, since (as is often asserted) almost all commercially-developed GIS have been designed and optimised for handling terrestrial rather than coastal or marine data; thus, the coastal GIS user was more-or-less forced to use tools and techniques that were inherently weak for the specific application(s) concerned.

In recent years, we have seen a move back towards the toolbox approach to GIS, this time based on a "plug and play" concept. The bricks in a child's "Lego" set offer a good analogy: in a "Lego" set, we find many general-purpose bricks, and also a smaller number of more specialized components. Whether generic or more specific, each piece has been designed to facilitate easy interconnection and, in this way, can be assembled so as to create whatever model the child wishes. Similarly, emerging standards of interoperability are encouraging software developers to create application-specific modules that "plug into" a core set of generic GIS functions. Thanks to this new approach, people will likely soon be able to select and assemble their own custom-built geoprocessing system from tools that best suit their specific needs and applications (in practice this assembly will often be undertaken for the end-user by specialist consultants or other intermediaries who are expert in system selection and interfacing). Some of the elements in these custom-built systems may be unorthodox by today's standards but, by integrating them within a single coherent framework, we will be able to harness the synergy of their interaction, and turn these separate tools (including many elements of existing GIS) into dedicated and specialized coastal information systems. A number of the presentations made at this meeting have reflected this evolution, and we already can see clear benefits, in terms of utility and flexibility of such approaches.

Making GIS more user-friendly

On the wider stage, there has been much discussion, and development effort, devoted to making GIS more user-friendly. The means of achieving this has been a frequent topic for debate in many GIS-related meetings and on-line discussion groups in recent years. The main concern here is to make GIS more accessible and thus optimise effective GIS use, because GIS is still often seen as being very complex. While these are important matters, are we approaching the problem from the right direction? Should we be trying to make GIS more user-friendly? Perhaps we should accept that GIS will always be inherently complex, since the systems are designed and developed to help us manage geographical complexity, and instead concentrate on providing appropriate training and education for users, in order to better equip them to use the technologies available. If not carefully thought-out and executed, enhancing user-friendliness could run the risk of coming perilously close to a "dumbing down" of GIS.

Institutional questions

We also need to consider the type of role that GIS is expected to fulfil within an organization, because this is yet another area where changes seem to be in progress. If we look at the early years of GIS, most of the pioneering systems tended to fulfil one of two primary functions, namely the digital production of maps on the one hand, and adding spatial search and retrieval functionality to databases on the other. In many contexts, GIS is still used for digital cartography, or as a means of storing, retrieving and displaying data using geography as the primary search mechanism. However, there is a move now beyond such uses, towards more integrated and advanced decision-support systems, where the GIS is actually helping decision-makers plan strategies and undertake other policy-making tasks. Going even beyond this important step, there is evidence that GIS is becoming increasingly adopted as part of a much wider scientific research methodology: this was particularly demonstrated in a number of presentations from our French colleagues at this meeting, where we saw GIS being used as an aid to better understanding of coastal processes, and other phenomena.

Standards

Somebody once said, rather cynically perhaps, that "the nice thing about standards is that there are so many to choose from"! We have heard much discussion here about standards. We were told how the researchers were faced with a choice between American and European standards for metadata, and in the end decided to take a hybrid. While it is all too clear why such a decision might be taken, one also wonders whether a hybrid between two standards is not rather defeating the purpose of having these standards in the first place? If the standards are not good enough, then perhaps they need revisiting and reassessment or revision. That is another question, but if we have standards, we should make every endeavour to adhere to them.

E-commerce

One thread which surprisingly has not been in greater evidence here is the whole idea of electronic commerce. It is an issue that is becoming more and more important, and surely it applies just as well to coastal data. The implications of using coastal data as a marketable commodity are issues that need to be considered as a matter of some urgency. The closest we came to discussing these important questions was when the movement or flows of information were touched on by a couple of speakers.

In this latter context, it seems worthwhile to suggest the metaphor of "data ecology". The name, and the imagery it evokes, are appropriate: in ecology, you have primary and secondary producers, you have different trophic levels, consumers and so on, and you get conversion and enrichment in the process. We do also have primary and secondary producers of data, and consumers of data, and so on. Couldn't this be an alternative way of looking at the circulation and use of data and information in our society?

The World Wide Web

Everyone is talking about the Web these days: it is a bandwagon that we all appear to be leaping onto for fear of being somehow left behind. In the process, we are investing a lot of time, effort and money in our endeavours, but are we adequately future-proofing our investments? Is the Web sufficiently mature (both as a concept and as a technology) for us to place so much reliance on it? There might be great potential danger in us all going so rapidly and eagerly down this one particular path, without leaving an "escape route" in case the bubble bursts?

Extending GIS

As far as applying GIS to the coastal zone is concerned, I think we all now accept that current technology is making definite inroads towards solving many problems, but equally there remain many issues still unresolved. As alluded to above, very few GIS are genuinely optimised for coastal, let alone, marine applications. It is surely worthwhile looking at the several alternative technologies available, or emerging in GIS, and consider how - if - they could offer solutions to some of these issues, and advances over our current ways of doing things. These alternatives include Cellular Automata, Voronoi Tessalations and related data structures, Genetic Algorithms and Virtual Reality (VR). This last, in particular, undoubtedly represents a technology of the longer-term future, but sustainable coastal management could benefit enormously from the successful and imaginative application of VR. If it is physically impossible to access a lot of the coastal zone, perhaps VR could "take us there" instead?

GIS is dead: long live GIS!

Someone in another context was suggesting that possibly GIS will have really "arrived" when it is so common place that we don't need to call it GIS any more; in other words when it is taken for granted that we are using GIS where such techniques are called for. We have still a fair way to go, but already some of the larger general-purpose software vendors are now producing off-the-shelf products that to all intents and purposes are GIS, even though the end user may not recognize the fact. This move towards embedded, ubiquitous GIS - such as are represented by in-car navigation systems - carries several important but, as yet, largely uncharted implications (and possible opportunities) for the coastal GIS community, and would merit careful monitoring and periodic analysis.

And finally...

As a closing observation, it may be noted that people tend to see "GIS" as Geographic Information Systems, with the emphasis on GIS as a tool. This is an issue frequently raised by a growing number of authors. For many, this "utilitarian" definition of GIS is restrictive and excessively narrow in focus. Instead, it is suggested that we should be decoding the acronym "GIS" as referring to Geographic Information Science, of which the process of automating the handling of geographic information is part, but only part, of the equation. This alternative definition surely receives much support when we consider the contents of many of the papers presented at this CoastGIS meeting, which show clearly the use of GIS not only as a tool but - as previously alluded to - as a distinct element in any scientific methodology. On this score, we should particularly commend those presenters who have included flow diagrams and "organigrammes" of their thinking in their papers. By capturing and presenting the thought processes and logical steps they have gone through, they underline that they are using GIS as a way of conducting science, for mining data for information, asking questions, and getting answers.

Cindy Fowler

Working in the coastal zone, we really have some unique problems that our land-based colleagues do not have. This land-water interface really complicates our lives. We have multiple agencies coming together, we have the history, the evolution of the mapping in the water with the mapping on the land. Trying to make those two come together in the coastal zone is very complex. There are three topics that should be addressed here, namely research and technology, legal implications and, lastly, lever aging information from the navigation community. This last is important, because they also have some similar databases that we need to work on.

Research and technology

In the area of technology, we still need to find data structures that can really address the 3D and 4D environment. We really need to push the research in that area, so that we can start looking at the water column, and at various temporal aspects of the coast such as tides and water movements. We can see that several system vendors are starting to respond to such needs: for example, the overall theme of the last ESRI user conference was "Ocean GIS", and the company gave the clear message that it is paying close attention to the coastal and ocean regions as an important marketing area. Hopefully, their interest (as well that of other vendors) will lead us to some different data structures and software to model this offshore area.

Then, there is the whole question of numerical modelling of the environment, rivers and streams and hydrology, an approach which is not yet very well married with GIS. Progress in this area has been very slow over the last 15 years. There will hopefully be a conference, coming up next year, on this theme of integrating environmental modelling with GIS.

Legal issues

As far as legal applications are concerned, a number of papers presented here have addressed the legal implications of, and frameworks for, applying GIS to the coastal zone. We are just covering some of the issues involved, and we have a long way to go. Our politicians, policy makers and lawyers are hardly paying any attention to such matters at present, and this is disturbing. In the United States, a lot of new legislation is being enacted without really looking at the impact of technology in the areas covered by these laws. We still have a lot of research, and also lobbying, to do in this area.

Navigation

Because hydrographers have been charged with mapping for safe navigation for so many years, many of our primary data sets (bathymetry, and also mapping of shorelines and other ocean features) come from this community. The hydrographic profession is starting to organize internationally, their products are becoming much more standardised, and they are starting to look at the overlap between access to data and use of these data in GIS and other applications. But members of the hydrographic community also tend to have a bias towards the shore, which suggests they are reluctant to pay attention to anything that doesn't impact directly on information needs for navigation. Thus, while they may collect wide-ranging data in the field, when it comes to creating their archives and databases, they are liable to throw away any bathymetric data that are not seen as relevant to their immediate needs. If the hydrographer is looking for shoals, for example, or other places that someone run aground, data relating to canyons or to a deep area of sea may often be thrown away; or, in a case of a shoreline, data update

may not happen if the shoreline is eroding, whereas it would be more likely if the shore was accreting. And yet these are also basic primary data layers that we need in the coastal zone for use by a much wider community. Since the money is clearly there to create the data sets for navigation purposes, we need to try to make their creators look at the broader picture, and remove the biases, so the data may acquire added value.

Roger Longhorn

Metadata

The coastal community is often not aware that the CEN/TC 287 committee completed all of its GIS-related standards over a year ago. The committee is actually wound up. The drafts of the standards have all been published, and are with the national standards bodies, though most of these bodies are not implementing the standards because they only are draft agreed standards, not mandatory ones, mainly because ISO was also producing standards in roughly the same areas.

What is still missing, though, is having a much higher level, a top level, of standards information, that enables us to find data more easily. And the only real standard that is coming in this latter area is not being pushed from a standards body at all. It is coming from the Dublin Core working group (named after Dublin, Ohio). We are trying to get an initiative going now, using Dublin Core "read data" fields to get into GIS, and geographic information generally, and we need to move that into the coastal zone as well.

Interoperability

On the interoperability side, under "systems", interoperability is also a standards issue. The Open GIS Consortium (OGC) is making tremendous strides in interoperability of GI systems, *i.e.* GIS tools, because the OGC is totally industry-based and is even paid for by the industry. It does have two or three national mapping agencies down the line, and one or two university research groups are also involved, but it is totally user-driven, and most of the standards it produces are developed by professional standards people who are seconded to the committee. But the OGC is only looking at systems, they are not looking at data; and basically the average GIS vendor is saying that it is important that his system be able to accommodate all different types of data formats that exist. To a certain extent current systems all do that. There are still a few specific data conversion problems, but the software is getting more clever, and the hardware is always getting more powerful for less money. In most cases, you need not worry too much about what standard you are following, provided that you are following a standard, because the vendor will normally have something that is able to handle that standard.

The Web

At present the Web's main impact relates to its use for discovery, to use it to find where other people have data, and help you get in touch with them. Once you find out where certain data may exist, you can then speak to the owners of those data on the phone, or perhaps send them a fax or an e-mail, to find out more about the data. Whereas the Web of the future is likely to be more interactive, and this will have an impact. We will use the Web not to deliver data, which is what it can do today, but as a means to deliver information. At present, you can download data from the Web, you can download some maps, you can find some metadata, but the day will come when it delivers you some information which you can then use to build up knowledge. But the Web is never going to deliver you some knowledge.

Away from maps?

At the Cambridge Conference this year (sponsored by the UK Ordnance Survey), there were 240 members, representing 72 mapping agencies from around the world. It was interesting that the main conclusion to come out of this conference was that most mapping agencies are trying to re-engineer themselves. A few of them, for example those in Sweden and New-Zealand, no longer talk of themselves as mapping agencies: they are geographic information repositories; they are geographic information resource centres. They are actually producing new marketing literature, to get away from the fact that they once made maps. In the future, a map is just going to be a by-product of something they do. Now this is a radical change coming from the mapping side of GIS, and it is an underlying model that goes much deeper. The coastal zone community is a user community of maps. We also do create maps, mainly for visualisation purposes, to get information across to a local council or whoever, but this latter role is also now being taken on board by mapping agencies themselves, partly because they are going digital. The Ordnance Survey in Great Britain no longer has any maps; there is no map library any more; the "map" is completely contained within the computer. You want a map? They will create a map for you. They can create whole new products in two days, a product they did not have two days earlier. It is all on the database.

Managing 3D and 4D

Looking at GIS generally, and coastal zone managers as users, GIS is extremely important, both as a data visualisation tool and as a spatial analysis tool. But it goes back to a paradigm from the early sixties, when it was developed in Canada. It was two-dimensional, whereas in the coastal zone we have always needed three-dimensional. Also, GIS has never had a time base on it - it is not temporal - which is also something we need in the coastal zone. It was interesting to hear the heads of two or three major GIS vendor companies in the last year, talking about these issues at major conferences, suggest that "these are technological problems with GIS, but do not worry, we are moving ahead, and

we shall solve the technical problems". In practice, we only saw experimental 3-D being built in to these packages in the past decade, and temporal GIS being built in during the past three or four years. They are still not ubiquitous and they need to be properly integrated with GIS, so we still have quite a way to go to get these tools to work properly. Until they do, no GIS packages at present can be used for process modelling by themselves. You have to create separate models to analyse coastal processes, and then use the GIS to show the results.

Impact of policy issues

There are a number of important GI policy-related issues in Europe that we need to be aware of, such as legal issues, access to data, the Freedom of Information Act, and so on. The importance of policy is often greatly underestimated. Certainly at the European level, especially within the 15 member states of the EU, if one good policy goes into place you can open up a whole new set of industries: for example, nobody five years ago thought we would see the national telephone monopolies of Europe broken but they are, and we can see all around us the results of this change in policy.

The European Commission is the executive body of Europe, and can issue directives that then have far-reaching down-stream impact. However, we are still lacking adequate European policies relating to GI. In five years of trying, five years of full-time lobbying effort, we have still not got a single person above the level of Director - and that is quite a low level within the Commission - to even accept that GI is important. Not GIS, not coastal zone GI, but even the basic concept of geographical information. So we are now embarking on another three-year effort to see if we can convince them that it is an important issue. We are going to be looking for some support from the user-community on this: for example asking you to lobby local associations, to get in touch with politicians, to find out who your Member of European Parliament is in Brussels and make representations to these people, because one well-placed policy change could have a huge impact on geographic information use, and possibly coastal information use, over the next decade.

François Cuq

Remote sensing

For a few years now, the pace of research in the area of remote sensing has slowed to a virtual halt, during which users have had time to become familiar with the existing technology. Thanks to various American, European and Japanese projects, we now have a clearer view of the world, seen through the sensors of a new generation of satellites. These are currently undertaking very high-resolution surveys of the world, using a number of spectral bands we had no access to in earlier years, especially with the arrival of multi-beam radar satellites. It is now time

to launch a new programme of research into satellite imagery, with a view to extracting information that will allow us to better calibrate and parameterise the models we are trying to develop for integrated coastal zone management, as well as to monitor the state of coastal dynamics. We should remember that satellite or airborne imagery is an excellent means of obtaining information, especially for replacing or augmenting ground-acquired information in a spatially-integrated and objective way. While the utility of such approaches is clear, it also raises very interesting questions about how representative they are of the real world, in terms of scale and spatial pattern.

Decision support

Important work should be undertaken in coming years, on the theoretical basis of decision-making. If we want to work on, and with, tools that are real decision-support technologies for integrated coastal zone management, we clearly need to understand the mechanisms by which decisions are made, and the foundations of decision theory, far better than we do at present. Some work is already underway in these areas, but these endeavours keep coming up against hard reality. Decision-support systems at present work well when applied to hypothetical scenarios, but work less well when these scenarios are based on real-world situations. If we really want to see progress towards a new conceptual generation of GIS, it is essential to integrate decision-making concepts into these new systems. And, more generally, it is absolutely essential to incorporate into such systems the means of modelling the behaviour of human society in all of its many forms.

Lionel Loubersac

A dynamic environment

During 1999, three important meetings took place in Europe that were dedicated to GI and the coastal zone. These were Info-Coast in the Netherlands in February, the UK meeting on coastal cartography in June and now CoastGIS here in France. In the last two meetings, the coastal marine community was well represented, while in the Netherlands it was relatively weak in contrast to stronger coastal land community representation. Interestingly, one of the conclusions offered at Info-Coast was the suggestion that GIS implementation problems for marine coastal applications are similar to those arising for land applications. This surely is something difficult to agree with, particularly when seen from an offshore perspective. Here, we are dealing with a fluid environment, where everything moves: tides, currents, swell, pollution, fishes, even people. The challenges are to represent this environment in three or four dimensions and perhaps our coastal community compares itself too much with the land GIS community.

A world without property

When modelling land territory with GIS, you are working with geographic objects, areas or structures that generally have a recognized ownership: the field, the lighthouse, the road, the forest, all belong to "somebody" that is more-or-less recognized by other people. When you go into the water, the system of territorial appropriation is completely different. The coastal marine territory belongs to nobody (or to everybody). One possible explanation for the fragmentation of coastal information is that it results from the various views of this territory, with corresponding fragmentation of responsibilities. Before the availability of GIS, this fact was hidden. As we saw in the session of this meeting devoted to legal aspects, GIS generally, and coastal GIS specifically, can be a provocative tool. Perhaps we should use it as such, that is to deliberately provoke some brainstorming about the problem of dividing this offshore territory from various points of view. The very big difficulty we have, arising from this, is to understand and represent how this fragmentation of territorial claims relate to the coastal system in its wholeness.

Conclusions

The wide-ranging and thoughtful presentations made at CoastGIS'99, as well as the closing panel discussion reported on here, provide ample testimony to the vibrancy of the coastal GIS community as we head into the 21st Century. With the very open community represented at our meetings we have a real possibility, at the international level, to foster the sharing of perspectives among researchers, decision-makers, and technicians coming from the separate fields of GIS and integrated coastal zone management respectively.

The need for approaches to coastal management that go beyond the purely local or national, and the various factors that currently mitigate against achieving these more global perspectives, were much debated in Brest. Of particular interest here, were the several discussions about cultural nuances, the comparative terminology and semantics used in describing (and understanding) coastal spaces, and the ways that these shape people's perspectives and impact on our appreciation, use and regulation of the coast. In this regard, the very cosmopolitan nature of the CoastGIS series of meetings was seen as a major asset that deserved to be exploited and further developed. For example, one specific suggestion was that CoastGIS participants might collaborate *via* the Internet, to develop a series of linked Websites, in French, Spanish, English and other languages as required, explaining how the coastal environment is managed in different areas around the world, and offering good illustrations and case studies of such management issues and information problems (and, if appropriate, their solution) found in each region. As

well as building on and further consolidating inter-personal and inter-agency linkages made during the course of the meeting, it was felt that such an initiative might also lead to the creation of actual tools of practical benefit to anyone tasked with developing integrated, and international, coastal management policies.
It was also suggested that the conclusions of these symposia might be drafted in English and French. They could then be made available, as part of a broader "outreach" and lobbying initiative to decision-makers, policy analysts and all others who work on the co-ordination of (coastal) geographic information in our respective countries and at the European Commission. The fact that CoastGIS is jointly sponsored by two of the major international scientific bodies in relevant fields, namely the Commission on Coastal Systems of the International Geographical Union, and the Commission on Marine Cartography of the International Cartographic Association respectively, underscores and emphasizes the influence that such an initiative could potentially have in helping to shape future coastal management strategies.

Finally, in spite of the quality of the presentations shown at CoastGIS'99, it was felt by some delegates that training programmes and other "technology transfer" problems had been somewhat overlooked when the contents and format of the meeting were decided on. Given that these are also very important issues, a suggestion was made that sessions devoted to these issues should be explicitly built in to the programme for the next CoastGIS meeting, due to take place in Halifax, Nova Scotia, in 2001.

Brest
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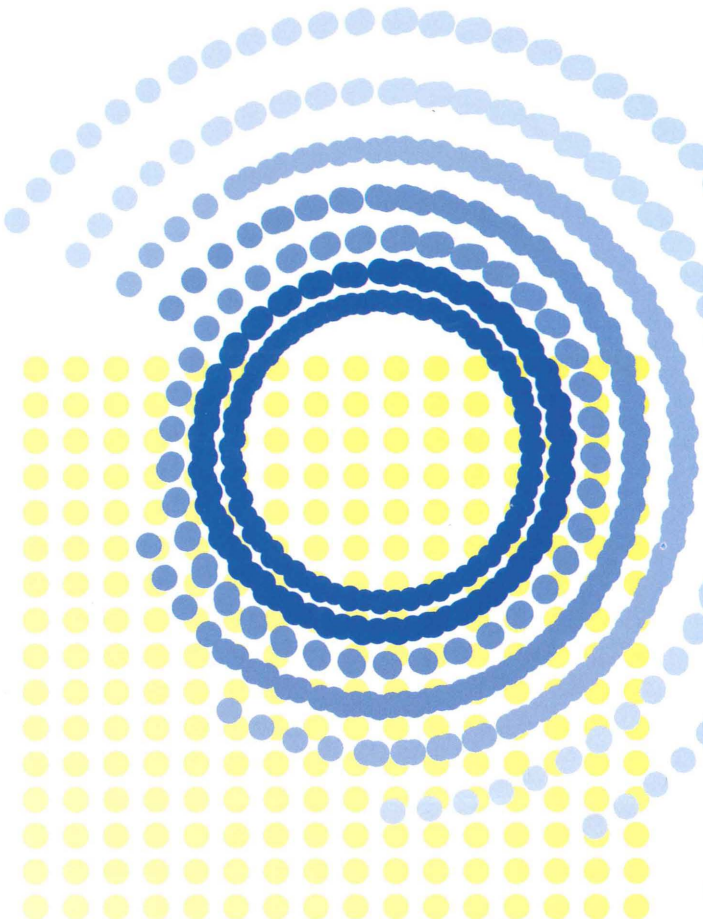
CoastGIS'99: Geomatics and coastal environment



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