CREEPING CRISES: DEVELOPING THE TECHNOLOGY OF COASTAL ENVIRONMENTAL MANAGEMENT

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ABSTRACT

Expert systems and crisis management constitute both individually and collectively new agendas within the realm of public management, policy research and development.

Creeping crises, as protracted disaster episodes which can, in a rapid succession of events, reach peak moments where danger materializes and transforms into acute crises, are not well understood in planning or decision-making terms. Not only are creeping, as against immediate, crises unconventional, because they lack the test of 'unness' (Hewitt, 1983: 10), they also represent a set of cases which prove taxing and intractable to many operating agencies. 'Denial', 'wait-and-see' and 'band-aiding' are common responses to creeping crises by government agencies and interest group supporters whereby ultimate responsibilites are often difficult to define, let alone to be held accountable.

Environmental crises deserve sophisticated policy and planning analysis for what they are: serious economic, political and, often, international issues. This paper seeks to develop GIS capabilites with more complex coupling of the issues of territory, task, technology and, especially, *time* within environmentally-specific protracted crisis contexts. Referring to Australian coastal ecologies, various planning phases, or paths, identify specific environmental factors and more complex institutional, technological and spatial relationships required for enhanced professional planning capabilities at local, regional and, even, national levels.

The 'time paradox' inherent in creeping crises demands an additional planning capability; one that might be called a capacity to understand and incorporate a *time budget* into GIS-based planning systems. Professional environmentalists and planners can move towards designing futuristic, simulation-capable GIS's crucial to the 'think locally, act globally' dictum. The paper identifies some design agendas necessary in enhancing such professional capabilities and creeping crisis planning effectiveness.

INTRODUCTION

At the 1993 conference of the Computer Simulation Society, several papers were presented to discuss the growing use of geographic information systems (GISs) for emergency/disaster management (Newkirk, 1993; Sullivan, 1993). For the most part, such work was studied in the temporal context of 'immediate crises'; that is, hurricanes, earthquakes and floods. This paper will not focus its attention on these well-known topics; rather, it will be less conventional and shift the focus of study toward 'creeping crises' (Rosenthal, 't Hart and Charles, 1989: 27-28). Such crises are unconventional because they lack the tests of 'un-ness' (Hewitt, 1983: 10): in practice, they are spatially specific (a wetlands ecology), monitorable (by scientific control standards), plannable (using GISs), predictable (as best-worst case scenarios) and, even, computable (by using machine-based simulations). Despite all of these obvious managerial advantages, however, ecologies are barely improving in nature - for example: wetlands deterioration; coastal deforestation; declining aqua-cultural protection; beach mining/erosion; river pollution (Jarman and Kouzmin, 1994b); and estuarine degradation. This list goes on. The US Vice-President (Gore, 1993: 42) is specific in this regard when he states: 'we see the destruction in slow motion'.

CREEPING CRISES: SOME INITIAL MODELLING

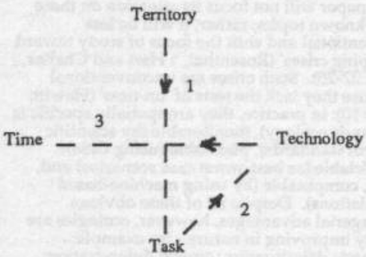
The persistence and geographic spreading of ecological/environmental degradation is ultimately more than a mere 'management' problem (Kouzmin and Jarman, 1989: 397-398; Rosenthal and Kouzmin, 1993: 8-10). Well-meaning coastal commissions, environmental protection agencies, local government planning agencies and others (even at international level) have not succeeded at 'stemming the tide' of such creeping crises. Therefore, *strategies* need to be reconsidered (Australian Resource Assessment Commission, 1993).

Use will be made of a relatively old, but unconventional, systems model developed by Miller (1959) which inter-relates three key variables strategically: Technology, Territory and Time. While respecting its original use, we will add the variable of Task. This addition allows one to manipulate these four independent variables in sequence so that for any environmental creeping crisis, as a time-dependent phenomenon, the following pattern of planning activity can be studied:

Path 1: Territory to Task
Path 2: Territory to Task to Technology
Path 3: Territory to Task to Technology to Time

In this schema (see Figure 1), more complex institutional (strategy/operations) relationships become necessary; spatial relationships are more focussed; technological options more open, while time-frames become more negotiable given the broad range of possibilities defined in Paths 1, 2 and 3. This situation may be expressed diagrammatically as shown:

Figure 1



Path 1: Territory to Task. In the case of Australia's coastal ecologies (Territory) three distinct zones can be identified:

Far North:	truly tropical, monsoonal hurricanes (zone 1)
Central:	Mediterranean climate, storm surges (zone 2)
Southern:	more temperate, severe storms, major river flooding (zone 3)

Our example of the localized 'creeping crisis' area will be the City of Wollongong in New South Wales (NSW), with a population of 180,000 people; generally a beautiful coastal site dominated by its steel industry. To highlight the issue of creeping crises, the GIS now being finalized by the City Engineering Department has been designed to perform the following tasks:

1. Procure state-level geographic maps in digitized form (State Land Information Council - SLIC) and then cleanup; that is, reduce the error rate in the data. Some of these error rates can be significant (greater than 20 per cent).
2. Finalize the database (digital) map as vector-related data in the mapping system (Hewlett, Packard/Genemap GIS).
3. Cross-tabulate this 'map' with the financial database stored in a different computer and make the two systems inter-operative.
4. Add engineering and planning attribute data layers to this GIS.

Path 2: Territory to Task to Technology. The second path, Territory-Task-Technology, constitutes logically a more complex configuration of the putative three-path schema. The new possibilities emerging from the next (and imminent) generations of aerial photogrammetry and satellites is mind-boggling (Jarman, 1993).

At an applications only level of analysis (demand-side), the relationship of a new generation of sensors (supply-side) to crisis planning generally is operation-level with regard to both monitoring necessity and capability. A brief list of enhanced applications capability will suffice:

- Weather forecasting (El-Nino Southern Oscillation);
- severe storm radar (NEXRAD);
- 'see-through' cloud radar (synthetic aperture radar, for example, Canada's KADARSAR, ESA's ERS-2 and Japan's J(ERS)-2);
- multi-band land monitoring (TM LANDSAT 7);
- land photography to resolution of 1-10 metres (US and Russian reconnaissance satellites);
- aerial digital othophotographic (various scales and GPS-enhanced resolution);
- local aerial photography using digital techniques; and
- NASA/Freedom Earth Observation System (EDS-EOSDIS).

The relevance of this new technology to 1997 (only three years) to the development to creeping crisis analysis may not immediately be obvious. A few guidelines may be presented briefly as follows:

- Base-map raster-to-raster digitizing of flood-plain/wetlands area;
- GIS layering (additional attributes) raster-to-vector for flood-plain scenarios (20-50-100 years); storm-water run-off (rural versus suburban); flora-fauna ecology;

toxic sediments; and hazards management analysis;
- traffic management planning (both normal and evacuation scenarios); and
- beach-area change (onshore/foreshore analysis; storm surge scenarios; storm-water pollution effects; flood chemicals spillage; estuarine ecological change; and ocean oil-spill scenarios).

To our knowledge, no Australian GIS is capable of providing such basic data on demand. But Path 2 of the schema requires such a comprehensive data-set and, certainly, the vector-based scenarios required for efficient and effective long-term creeping crisis strategic planning. In this sense, demand far outstrips supply and will continue to do so even when the terrestrial/space technological capabilities come 'on-stream' later in the decade.

Even worse, if viewed from the strategic perspective of an individual local authority (LA), even in Wollongong City with a budget in excess of $A150 million, the cost-effectiveness of such enhanced systems remains problematic. Some reasons are:

- Inexperience of general staff using the existing GIS (training);
- cost of additional GIS layers which are non-revenue generating (net revenue ratio low); and
- inexperience of professional staff with space technology applications to date (future applications knowledge).

In adding the new layers, engineers might want to specify the mapping coordinates of such facilities as road-centre lines, kerb and gutter locations, man-hole centres and water/sewerage piping layouts. This data must be geographically accurate relative to cadastral points (ground truthing) and today is verified using either conventional surveying techniques or differential Global Positioning Systems (GPS).

If regarded as a 'southern zone' city, the basic GIS described above would need to be enhanced for ecological monitoring purposes whereby five immediate layers would need to be added:

- Flood-plain mapping (20-50-100 years);
- toxic materials sedimentation;
- storm-water run-off patterns;
- flora and fauna wetlands data; and
- new suburban (West Dapto) evacuation schema.

Wollongong City monitors some of this necessary data which is now used as part of the Council's GIS.

The Territory-Task-Technology relationship constitutes an important analytical starting point for the development of an ecologically-relevant GIS. Normally, enhanced flood-plain GISs are a good way of defining operationally the relevance of creeping crises in such an area: toxic sedimentation; flora-fauna development; upstream suburban area flooding impacts and, finally, beach erosion. As for the impact of these new systems on the Pacific Ocean's aqua-culture potential, only guesses can be made at this stage of planning. Finally, in a topologically-structured GIS 'what if ... ' scenarios can be considered by strategic planners (for instance, rising ocean levels). Problems, however, remain with two prominent issues being:

- Uncertainty of mapping/GIS/GPS policy of both state and commonwealth governments concerning technical capability and cost-sharing arrangements; and
- intellectual property disputes both within LAs (staff innovations) and between LA and SLIC (royalties, licences and fees policy).

In summary, the Territory-Task-Technology combination represents a general mixture of institutional conservatism and technological opportunity (Rozzoli, 1992). The best data available at local levels may simply not be used by others outside the datum LA. The legal, financial and applications variables need to be considered as early as possible in the development of the creeping crisis-type GIS. This matter requires urgent consideration in all spheres of government.

Path 3: Territory to Task to Technology to Time. By adding the time dimension (Clark, 1985; Zerubavel, 1981; Benini, 1993) to the other three variables, a quite complex set of inter-relationships has been defined so far as creeping crises management (Jarman and Kouzmin, 1994b) is concerned. In theory, at least, it is possible to presume that, in this context, 'time is on our side'. Without wishing to appear unduly pessimistic, however, it is possible to state a worrying paradox based on the environmental management record of governments during the past 20 years.

The paradox implicit in Vice-President Gore's (1993) statement above may be written as a hypothetical statement: 'The more time governments have, so the more time they seem to need' to solve such non-routine, and presumably non-urgent, types of crises.

In Australia, the Territory-Task-Technology-Time situation is demonstrably complex in many ways: the least complex of which ironically is 'technological'. More abstractly, the concept of a *time-budget* stated as a supply/demand equation is curiously absent from much of contemporary governmental policy-making. Therefore, this type of time-budget needs further analytical scrutiny and development. Briefly stated, the temporal situation is as follows:

Demand-Side

- Governmental spheres which do have the input resources (especially at federal level) do not always possess the legal powers and/or political will to recognize that 'a problem even exists' ('t Hart, Rosenthal and Kouzmin, 1993; Jarman and Kouzmin, 1993: 19).
- When seeking to gain such governmental 'attention', non-governmental groups seek to dramatically use 'media-grabs' so as to incite 'crisis-states' of affairs (Rosenthal, 't Hart and Kouzmin, 1991; 't Hart, 1993). The 'cry wolf' syndrome can ultimately effect the intensity of such messages to government and the general public.
- In the past, conventional science policy advice concerning such imminent 'crises' does not seem to have been able to instil a sense of urgency in most key policy groups within government (Rosenthal and 't Hart, 1991; Jarman and Kouzmin, 1994a).
- Technologists seem to have fared even worse in the 'centre of power'. As 'non-scientists', they seem to lack causal knowledge credibility with government.
- Community-level advocates, whilst articulate locally, find it difficult to develop even a state-wide support base, let alone one of national significance.
- Governmental science bureaucrats are not always free to speak - either by tacit disapproval or censorship, or to publish findings which may embarrass governments or private industry.
- LAs, who know their local needs best, are not well-resourced enough to develop their own basic GISs quickly enough for routine uses, let alone more 'exotic' applications (Wolensky and Wolensky, 1990).

Supply-Side

- LAs and other governmental mapping/environmental protection agencies suffer from an already chronic 'deluge of data'. The advent of digital orthophoto and, even worse, synthetic aperture radar (SAR), will only exacerbate this data overload.
- Until more sophisticated 'data comprehension' software systems become operational, this data glut may well impede 'information-level enhancement' whereby better scenario-generation, decision support and expert systems cannot be afforded because of data handling costs.
- Software operating systems inter-operability, while problematic at local level (say, for water-shed modelling coordination), is likely to be even less useable with regard to the new generation of federal environmental data-bases.
- Even where such federal-local inter-operability is technically possible, federal data is likely to be, in mapping terms, of inappropriate scale and resolution for effective use as a data source at local level.
- With regard to space technology, the (Australian) federal sphere of government is almost wholly dependent on overseas data sources (NASA, NOAA, ESA, JSA). As such sources seek to commercialize because of governmental 'user pays' requirements, so vital types of data (for example, SAR) may not be 'affordable'.
- Many LAs will need to be encouraged by the provision of governmental subsidies to add ecological/environmental data layers and information system enhancements to their parochially-designed databases.
- LAs, even of the innovative variety, will continue to need expert support so as to develop, quickly and effectively, expert system prototyping capability. This is a matter of genuine urgency (Hadden, 1989).

CONCLUSIONS

Since 1989, a renewed governmental effort concerning environmental issues has forced itself onto the global agenda. The UN conference in Rio, in July 1992, represented the largest meeting ever of heads of state and G 7 governments (Adede, 1992). At that historic meeting, the world was urged to 'think locally, act globally'. More recently, the international business community has pointed to the eventual development of a goods and services industry of $US200-300 billion by the Year 2000 (Crawford, 1991).

This short paper has concentrated on this exhortation to 'think locally'. It has sought to provide a first approximation schema to help professional environmentalists and others to do just that. A well-designed, futuristic, simulation-capable GIS is an important step toward this goal. The schema, applied to Australia's eastern seaboard, has been used to derive three important issues for further local-area policy makers to consider.

Path 1: Territory to Task. Determine, by mutual agreement, at an inter-government level of discussion, the *datum standards* of environmental control relevant to the territorial issues of local importance. The levels of nutrients entering the pristine ocean waters of the coral Great Barrier Reef (Zone 1) *must be less* than for southern waters (zone 3).

Path 2: Territory to Task to Technology. Begin immediately to integrate and incorporate into local-level GISs both terrestrial- and space-related technological capabilities. Simply entering the digitized GIS data itself can be a monumental and expensive task (probably 75 per cent of the total operating system). Space-sourced data requirements will be even more demanding. But, as such data becomes more appropriate to the needs of local-level agencies (scale and resolution enhancement), so LAs need to be experienced with its use. For most professionals, learning to use such novel technology can constitute a decided technical challenge (Kouzmin and Jarman, 1990; Jarman and Kouzmin, 1991).

Path 3: Territory to Task to Technology to Time. One seeming paradox has been asserted regarding common official responses to creeping crises: 'The more time you have, the more time you seem to need to solve such problems'. Perhaps it is time for local and regional agencies to forget (for the moment) their day-to-day budget issues and begin to prepare *time budgets*, perhaps using basic Critical Path Method (CPM) techniques. To perform this task professionally, however, the basic agreements required in Path 1 must be substantially achieved. Moreover, Path 2 also needs to be known so that the critical 'learning curve' aspects of the developing technologies can be tested by local-level prototypes for their cost-effectiveness.

Finally, all three creeping crisis paths need to be considered now as a matter of local/regional urgency. As this paper has suggested, overcoming local/national/global inertia is no simple or easy task. On the other hand, local activists are now increasingly articulate about their needs, state agencies are becoming more responsive to local planning systems (which will differ from place-to-place), most of the technology is already operational and, significantly, applications cost-benefit relevance is better understood. Importantly, some business people are interested in an emerging market place while globally the United Nations will play a continuing role in bringing some of these issues to international attention - an achievement in itself. Conceptually, this paper does not seek to address all of these issues - it is one modest attempt only to specify one way that 'think(ing) locally' might be considered as a strategic challenge but tactical opportunity.

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