And if Geospatial Data Infrastructures were fragmented and splintering?[1]

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Abstract

Notwithstanding conceptual and theoretical developments regarding GDIs their practical and operational implementation appears problematic. The paper addresses the question whether the promise of GDIs also holds for developing countries and explores some conditions and factors in this respect. To this end, the paper offers a framework for observing and analysing GDIs as facilitator of communication, as infrastructure, as socio-technical system, as common-pool resource, and as community of practice. The paper suggests that institutionalisation of GDIs will be a fruitful concept in that it brings together salient conditions and factors for their sustained performance.

Key words:

GDIs, socio-technical systems, Actor Network Theory, institutionalisation.

Introduction

Geospatial Data Infrastructures (GDIs) seem to be another 'promise' within the continuous development of geographic information technologies. GDIs aim at the sharing, accessibility, and use of geospatial data and encompass institutional, organizational, technical, human and economic resources[2]. As such, the very notion of GDIs reflects the understanding that geographic information technologies – like any technology for that matter – go beyond technicalities alone and have to include 'the social' as well. Notwithstanding proliferation of conceptual and theoretical developments regarding GDIs their practical and operational implementation appears unruly and problematic. Hence, the question whether the promise of GDIs also holds for developing countries needs to be dealt with. What are the potentially enabling conditions and what are possible bottlenecks? Developing countries are poor for reasons other than lack of money only. Their poverty extends to information, trained manpower, and public institutions. In addition, developing countries lack functional redundancy as reserve, and security – but above all as facilitator of change (Caiden and Wildavsky, 1974). It would then follow that GDIs should see how existing potentials and institutions could be preserved – if not strengthened – rather than just being innovative and modern[3]. The paper aims at exploring some of the salient conditions and factors in this

[1] Free after John Law and Annemarie Mol (2002).'And if the Global Were Small and Non-coherent?'
[2] Groot *et al.* (2000), for example, describe GDIs as encompassing the networked geospatial databases and data handling facilities, the complex of institutional, organizational, technological, human and economic resources, which interact with one another and underpin the design, implementation, and maintenance of mechanisms facilitating the sharing, access to, and responsible use of geospatial data at an affordable cost for a specific application domain or enterprise.
[3] This is obviously no plea for conservatism *per se*.

respect and offers a framework for observing and analysing GDIs rather than another theoretical concept for GDIs *per se*. To this end, the paper borrows from a series of scientific traditions that – I assume – surround the concept of GDI.

First, GDIs are supposed to facilitate communication. Recent developments in (political) sociology of language may help in identifying some conditions for communication and exchange within GDIs, and barriers for this potential. For example, powerful actors may prevent others from having full and direct access to GDIs. Second, GDIs can obviously be viewed as particular instances of 'infrastructure networks' in general. As network GDIs have external effects ('network externalities'): the more human and organisational actors participate in a GDI the more each of them will benefit. But GDIs would likewise also have potentially *fragmenting, discriminating, and excluding effects*. Third, because GDIs encompass both technical and social elements they may therefore be regarded as *socio-technical systems*. In particular the so-called Actor Network Theory helps in understanding how GDIs emerge out of continuous processes of *mutual negotiations* between human, technical, and other kind of 'actors' as proponents, (potential) allies and opponents. Fourth, performance of GDIs can also be perceived in terms of *common* resources. Problems of abuse and misuse of common (-pool) resources and possible solutions to these problems are dealt with by tradition of 'coping with tragedies of the commons'. This intellectual tradition provides a repertoire of concepts and approaches that may help in identifying critical factors for success and failure of GDIs. For example, the notion of 'co-production' between various actors would draw attention to synergy within GDIs and broadens the scope of analysis, which is often limited to issues such as monopoly, markets, and privatisation. In addition, the notion of 'polycentric systems' may help in understanding GDIs as complex adaptive systems. Fifth, to the extent that GDIs have to cope with and adapt to their respective environments, GDIs must exhibit the capacity to *learn*. This situated learning is essentially a social process and comes largely from participating in a 'community of practice'. Finally, 'new institutionalism'[4] may help in observing and analysing the assumed communicating, connecting and sharing abilities of GDIs and their sustainability within a unifying conceptual framework.

These different perspectives are of course not mutually exclusive and more perspectives (and metaphors) might be relevant as well. In the remainder of this paper each of these perspectives will be briefly reviewed.

GDI and barriers in communication; power positions

GDI is about communication and sharing of data and information. The ability of communication is what GDIs have in common with language. De Swaan (2001) approaches the communication potential of a language – or rather language repertoire – as the product of its prevalence and it centrality[5]; the product of the proportion of those who speak it among all speakers in a given language constellation and the proportion of multilingual speakers whose repertoire includes the language among all multilingual speakers in the constellation. He asserts that the resulting Q-value not only serves as a rough-and-ready measure for the communication value for the communication value of a language in a given constellation but also purports to reconstruct the 'value' that speakers attribute to that language; an evaluation that guides their choices of foreign languages to learn. People will prefer to learn the

[4] For 'new institutionalism' see, for example, March *et al*. (1989) and North (1990).
[5] De Swaan (2001), p. 21 and pp. 33-40.

language that most increases the Q-value of their repertoire. This evaluation would then be a major mechanism in developing towards constellations of languages with ever increasing Q-values and at the same time, along with this, abandoning languages with lesser Q-values. But choices of 'foreign' language to learn may be influenced – or rather curtailed – by other factors as well. In some former French colonies in sub-Saharan Africa for example, French not only was the language of the colonial ruler but also continues to be the language of the local elite. For French continues to be the language of all scientific and technical knowledge, of administrative and legal expertise, of political discourse, of wealth, power and prestige. The vast majority of the common people are willingly or unwillingly excluded from *direct access* to all this codified knowledge. The result is consolidation of the status quo of the elites as 'gate keepers' to this knowledge. In this manner, language is perverted from a means of communication into a means of exclusion and continued domination[6].

The similarity between GDIs and language as means of communication is striking. GDIs *may* facilitate the sharing, access to, and communication of geospatial data as this is generally suggested in literature. But like in the case of language, this potential is subject to the existing power constellation as well. Some actors may maintain their powerful position and prevent others from direct access to the GDI. In this sense, GDIs may become means of exclusion and domination.

Splintering infrastructures

GDIs are networked infrastructures and, therefore, share the characteristics and fate of infrastructures in general. In their seminal book on the urban network society, Stephen Graham and Simon Marvin (2001) discuss how contemporary networked infrastructures do not necessarily adhere to the infrastructure ideal of modernism; the ideal of rolling out monopolistic, standardised and integrated infrastructure networks to cover a city, region or country that was associated particularly with the period 1850-1960[7]. Instead, as they point out, modern infrastructure development generally help sustain the fragmentation of the social and material fabric of these spatial entities[8]. Often, this fragmentation takes shape of exclusion and segregation in a struggle between different social groups and interests. For the construction of spaces of mobility and flow for some always involves the construction of barriers for others[9].

Graham and Marvin identify a number of factors that undermine the "collapse of the modern integrated ideal" in urban infrastructure development as they put it. These are: the ever-growing financial burden of deteriorating existing urban infrastructure (the urban infrastructure 'crisis'); changing political economies and governance, and the retreat of the (welfare) state; the collapse of the comprehensive ideal in urban planning and the emergence of isolated projects; the physical growth and extension of metropolitan regions; and the challenge of different and competing social movements and critiques[10].

Many infrastructure activities generate *network externalities* where all users benefit when a new user joins the network because of the ability to communicate with more people[11]. De

[6] De Swaan (2001), pp. 102-106.
[7] Graham *et al.*(2001), p. 426.
[8] Graham *et al.*(2001), p. 33.
[9] Graham *et al.*(2001), p. 11. See also Chapter 6: "Social landscapes of splintering urbanism".
[10] Graham *et al.*(2001), Chapter 3: "The collapse of the integrated ideal".
[11] Graham *et al.*(2001), p. 147.

Swaan, who considers language as a 'hyper collective good', makes a similar observation. The more people use a language, the more valuable it is to each one of them[12]. But, as we have seen, existing power constellations may seriously restrain these forces. Moreover, modern infrastructure developments like GDIs potentially create the threat to individuals and groups of being marginalized and subsequently being excluded altogether from such emerging networked infrastructure.

GDI as a socio-technical actor network; sociology of translation

GDIs encompass both technical and social elements. The question whether technology is primarily technical or primarily social has been extensively dealt with in the literature, notably in the realm of Actor Network Theory[13]. Some view technology as socially constructed but technology certainly may have a profound impact on social relations as well. Hence, concrete instances of technology can be considered as socio-technical systems; truly heterogeneous systems where nor the technical nor the social dominate the other. The term 'socio-technical system' reflects our common understanding that both technique and social actors are prerequisite for 'technology' being meaningful. This is obviously the case for information and communication technologies (ICTs) like GIS-technology. Similarly, some view GIS both a technique and social relation[14].

The social construction of technology[15] brings with it that concrete instances of technology emerge in a continuous process and interplay between human and technical actors. It also implies that that 'technology' is a dynamic rather than a static concept. Moreover, the (social) construction of technology implies a process of continuous negotiations where different actors attempt to influence the courses of action open to other actors. Michel Callon has coined this process 'sociology of translation' (which is synonymous for Actor Network Theory)[16]. It is the process of creating alignment amongst potential allies and comprises four stages:

- problem (re-) definition. Some actors work together to define a problem so that other actors recognise it as their problem too;
- locking allies in. Actors lock allies into collaboration; some actors become indispensable to others;
- defining new roles. New situation is achieved through various mechanisms (persuasion, threat, inducements, etc.) and old network may dissolve;
- sustenance. Sustenance of the new situation is achieved; or, at least, relative sustenance.

Actors may be both human and non-human. (The latter comprise nature and technical artefacts.) Actors interact with other actors and in doing so, they put *intermediaries* into circulation, like texts, maps, aerial photographs, technical artefacts, human beings (skills, knowledge), or money. They define one another in interaction – in the intermediaries they put into circulation. Actors could be intermediaries themselves and eventually may be simplifications of networks ('black boxes'). Some actors may become indispensable to other actors and/or intermediary between networks ('obligatory point of passage'). *Boundary*

[12] De Swaan (2001), p. 27.
[13] See, for example Bijker (1995), Bijker and Law (1992), and Law (2000).
[14] See, for instance, Pickels (1995) and Sheppard (1995).
[15] Or, for that matter, the technical construction of society.
[16] See for 'Sociology of Translation' for instance, Callon (1980 and 1986) and Law (1992). In the original literature, 'sociology of translation' comprised of four stages: problematisation, interessement, enrolment, and mobilisation.

objects help actors from different networks (or communities) to interact by providing shared understanding. To this end, boundary objects must be adaptable to different viewpoints on the one hand and robust enough to maintain identity across different sites on the other[17]. Boundary objects are acknowledgement and discussion of differences between communities that enables a shared understanding to be formed. While the loose definition of a boundary object is helpful in initially bringing groups together, this looseness can also be detrimental. Ultimately, the different communities may interpret boundary objects differently.

Actor Network Theory may help in identifying conditions for relatively stable GDIs[18]. It should be remembered, however, that GDIs like all socio-technical constructs are subject to continuous 'translation' between heterogeneous actors and, hence, are – and remain – potentially unstable. Nevertheless, and all other conditions remaining equal (*ceteris paribus*), simplification of a GDI by 'translation' or negotiation may reduce arguments and conflicts on loopholes and loose ends. Addressing and defining only a limited number of possibilities and keeping some 'black-boxes' closed can achieve this. On the other hand, multiple and redundant interactions between constituent actors may diminish the dangers that are associated with strong "obligatory points of passage". This also implies that political support is necessary for sustained GDIs but no single predominant and powerful actors.

The tragedy of GDIs that do not provide geospatial information

GDIs are supposed to support and be utilised by a wide group of actors; collectors, processors, providers and users of geospatial data. However, each individual actor will be inclined to recognise that often "information is power" and, consequently will be reluctant to share that information with other actors. As a result, the ability of GDIs to provide information may seriously be curtailed. In general – and as we have seen this before – actors' self-interests may be detrimental to the promises of GDI. In other words; self-interest may be at odds with common interests. This general theme was addressed by Garrett Hardin (1968) arguing that users of common-pool resources ("commons") are caught in an inevitable process that leads to the destruction of the resources on which they depend. In this respect, GDIs might be fruitfully viewed as a particular instance of common-pool resources. Indeed, we may well call it "tragic" if GDIs would inevitably not be able to fulfil their (technological) promise if not their very reason of existence.

One way of coping with this "tragedy of the commons" is to strengthen central control. However, this would not only mean that the very characteristic of a "commons" might be jeopardized. It also might contradict contemporary trends of "good governance" as these are discussed in academic and professional circles. However, these dilemmas might also be dealt with in a different way than by central control. Empirical evidence has shown that their users can effectively manage local-scale common-pool resources for very long periods of time. Local communities apparently were able to craft appropriate institutions. The work of Elinor Ostrom and associates at Indiana University has produced several concepts and approaches that may also be useful in our present discussion on the effectiveness of GDIs[19]. For example,

- *polycentric arrangements*. Multiple centres of power (and jurisdictions) may better reflect diverse preferences and values and could make better use of local knowledge

[17] See also, Star *et al.* (1989).
[18] See also, Martin (2000).
[19] Workshop in Political Theory and Policy Analysis, Center for the Study of Institutions, Population, and Environmental Change, Indiana University, Bloomington, Indiana, U.S.A. (http://www.indiana.edu/~workshop). See for an outline and synopsis of some of the concepts: Ostrom (1990, 1999 and 2000).

and practices. Polycentric institutional arrangements may achieve order and high performance through competition as well as cooperation. Some degree of redundancy may reduce the danger of failure for the entire system;

- *self-organisation*. To be effective, collective-choice rules must be institutionalised. This, in turn, requires some degree of self-organisation.
- *coproduction.* Production of all services involves some active input from consumers as well as from the producers of these services. For example, medical doctors *and* patients together constitute healthcare.

An approach to GDI that allows for distributed jurisdictions, some degree of redundancy and self-organisation, and active involvement of all actors may contribute to its effective and sustained operations and, hence, to its success.

GDI as complex adaptive system; ability to learn

GDIs like other socio-technical constructs operate within a highly unstable environment. Their ability to adapt is key to their sustainability. In this respect, GDIs are complex adaptive systems. Adaptation to evolving circumstances, in turn, implies not only the ability to learn but specifically also the ability to learn how to learn[20]. Learning may address needed adaptation to internal as well as external circumstances.

Learning is social and comes largely from our experience of participating in daily life. In complex adaptive systems learning may occur through informal and loose associations for sharing experiences, insights and information about the operation and performance of the system. This kind of associations (or groups) has become known as a 'community of practice'[21]. A community of practice have three distinguishing characteristics. First, communities of practice are obviously formed around a shared practice that matter to people. More than an interest, members are able to develop a shared collection of resources: stories, experiences, tools, best practices, and so on. Second, communities of practice emerge around expertise rather than bureaucratic hierarchy. Third, communities of practice are only responsible to their members. In this sense, they are fundamentally self-organizing systems. Communities of practice are able to influence the 'host' systems in which they are implicated through the development and maintenance of social capital among community members. This social capital, in turn, mobilises and facilitates the ability for the host system to learn and to adapt to (changing) circumstances[22]. It would follow that the sustained performance of those complex socio-technical systems like GDIs will be facilitated by informal groups of involved actors (producers, operators and users) with high degree of mutual trust rather than by formal, hierarchical and bureaucratic arrangements.

In conclusion: institutionalisation of GDI as a unifying concept?

Not surprisingly, the aforementioned perspectives for looking at GDIs do have much in common. All revolve around GDIs to be embedded within broader social structures. It also becomes clear that GDIs are not "given" and static concepts but emerge in a process of continuous negotiation between heterogeneous groups of actors. In addition, effective and

[20] For organisational learning, see for instance, Morgan (1997). The distinction between learning and learning-how-to-learn is similar to single-loop learning and double-loop learning (Argyris et al., 1978).
[21] For 'communities of practice', see for instance: Smith (2003), Wenger (1998), and Lesser *et al*. (2001).
[22] Lesser *et al*. (2001), p 833.

sustained operation of GDIs requires continuous support. Like with other application of (geographic) information technology, support structures are needed for professionals and users, for system's maintenance, and for organizational operations and responsibilities. Support also have to deal with conditions for the acceptance of geographic information technology and its resulting information, with conditions for sustained operation after implementation, and with the ability to cope with change. Support structures do not emerge and do not continue to exist automatically. They need (political) commitment[23]. Support, in turn, would imply that those who will provide for it consider the GDI as relevant for the often-problematic situation they face. Finally, GDIs are a special case of geographic information technology in that they are generally not confined to a specific organization. Moreover, GDIs have to deal with other than conventional spatial data and information as well[24]. In short, GDIs are embedded within broader societal systems (or contexts) – be it at the national or at local level[25] – in which they facilitate communication and sharing of data and information almost as taken-for-granted between wide varieties of actors.

When GDIs are embedded within social groups or within society at large then they must fit within existing cultures and institutions. *Culture* is the shared ways of thinking and believing that grow out of a group experience and are passed from one generation to the next. It is the way of life, the knowledge, beliefs, customs, and skills available to its members. Specifically, it refers to the deeper level of basic assumptions and beliefs that define in a basic taken-for-granted fashion a group's view of itself and its environment. These assumptions and beliefs are learned responses to the group's problems of survival in its external environment and its problems of internal integration. An *institution* is an established way of organizing social life and a pattern that is valued by the group. It is a stable cluster of norms and normative behaviours that develops around a basic social need. One of the distinguishing characteristics of an institution is its normative impact on behaviour of individuals. In this sense, institutions are part of the host culture. Institutions can take the form of rules, enforcement mechanism, and of organisations. The sociological view, however, implies that institutions must have a normative impact on behaviour; whether they are organisations or not.

Societies are tied together through institutional arrangements. These are not static however. Existing institutional arrangements may become less effective due to changing conditions within the local society and within its external environment. Some existing institutions may weaken or even cease to exist. New institutions may emerge. Because social systems are evolutionary and adaptive, their social needs will change and, hence, their institutional arrangements may evolve as well. This dynamics of institutional development is an essential characteristic of institutions and depends on how well the institution addresses a social need. In heterogeneous social groups and societies institutional development will be different for different sub-cultures[26].

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[23] See also, De Man (1988 and 2000).

[24] At local level, this information is often in terms of indigenous knowledge, folk perceptions of the world, narratives (stories) and images rather than in texts and tables.

[25] Embedding GDIs in international (or supra-national) contexts face similar problems as, for instance, institutionalization of international law does.

[26] See for more thorough elaborations of cultural and institutions; Broom *et al.* (1981); Douglas (1978); Hofstede (1980 and 1997); Robertson (1982); Schein (1985); Thompson *et al*. (1990); Uphoff (1986). See for an elaboration of cultural conditions for the application of GIS; De Man *et al.* (2002). The growing interest in institutions ("new institutionalism") is reflected by several 'land marks' in the literature: *Local institutional development* by Norman Uphoff (1986); *Rediscovering institutions; the organizational basis of politics* by James March and Johan Olsen (1989); *Governing the commons; the evolution of institutions for collective action* by Elinor Ostrom (1990); *Institutions, institutional change, and economic performance* by Douglass North (1990); *The Institutional Imperative; the interface of institutions and networks* by Anton C. Zijderveld (2000).

Institutions can be formal or informal; the latter being specifically rooted within local societies (communities). For the world's poor, informal institutions play a primary role in running their affairs. In richer countries, formal institutions complement informal ones[27]. Some view modern information and communication technologies, like e-mail and internet, their promises for participation, and, specifically, their 'virtualisation' of reality as adding to or, sometimes, replacing earlier institutions of the state[28]. In effect, for some the world is becoming a 'global village'[29].

From the foregoing, it would then follow that from an institutional point of view GDIs have a two-way relation with the societies in which they are implicated. First, GDIs must fit within – or at least be compatible with – existing institutional arrangements. In short, institutional arrangements matter for the information flows within society and thus for GDIs. Second, GDIs themselves could play an institutional role within society. From the earlier sections it may be clear, however, that some caution is appropriate when considering the potentially institutional role of (geographic) information technologies or modern information and communication technologies in general. They may bring social inclusion as well as social exclusion. Both access to such technologies and 'literacy' in their use is not necessarily evenly distributed socially and geographically. In addition, 'becoming a global village' may also bring with it loss of local social context and alienation.

The view that GDIs themselves could play an institutional role is fruitful for several reasons. First, it focuses on the effectiveness of GDIs in dealing with commonly felt problems in society. (The sociological view of institutions would refer to such problems as to "social needs".) In other words: GDIs are means to ends and not the ends themselves. Second, the institutionalisation paradigm revolves around actors and their problem-solving behaviour. *Institutionalisation* would then refer to an ongoing process within a group or society whereby a concrete GDI is being valued and gains a strong and (almost) normative impact on common perceptions of spatial problems and, subsequently, on collective actions to remedy these problems[30]. This process of becoming collectively valued, in turn, is conducive for the required support for GDIs. Participation in the design, operation and use of a GDI is key to its institutionalisation. Finally, the institutionalisation paradigm brings the earlier mentioned perspectives together but does not replace them. Institutionalisation of GDIs is no panacea, however. One cannot create and impose institutions from outside. All we can do is to look for *conditions* for institutionalisation; some minimum degree of togetherness and homogeneity. Strong social cleavages within groups and communities pose barriers in communication as we have seen before[31]. But what are in those cases the institutional bonds that keep society still together? Can we still speak of "social problems"[32] or are we faced with sets of individual and group problems? The institutional paradigm emphasises societal feasibility and acceptance of technical solutions like GDIs rather than their sophistication. It points at the often-needed strengthening of existing public institutions and creation of functional redundancy of public services – a condition prevailing in most developing countries. It also bears the promise that once accepted and valued, the emergence of GDIs in

[27] See, for instance, World Bank (2002). In this respect, some see lack of public institutions as a major problem in many low-income countries (e.g., Caiden *et al.*, 1974).
[28] See, for instance, Frissen (1999).
[29] See, for instance, Credé *et al.* (1998).
[30] See also De Man (2000).
[31] See also Coleman (1976).
[32] Merton (1976, p 7): "a social problem exists where there is a sizeable discrepancy between what is and what people think ought to be".

society become a self-propelling process. In this respect, the institutional paradigm does not deny the continuous processes of negotiation and "translation" of GDIs but suggests conditions for stability and – eventually – sustainability. The institutionalisation paradigm, so to speak, contributes to the formulation of terms-of-reference for socially accepted and valued GDIs. In this respect, *institutionalisation of GDIs is a truly unifying concept*.

Literature

Argyris, Chr., and D.A. Schön, 1978. Organizational learning: a theory of action perspective. Reading Mass.: Addison-Wesley.

Bijker, Wiebe E., 1995. Of bicycles, bakelites, and bulbs: towards a theory of sociotechnical change. Cambridge, Mass.: The MIT Press.

Bijker, Wiebe E. and John Law (eds), 1992. Shaping technology/building society; studies in sociotechnical change. Cambridge, Mass.: The MIT Press.

Broom, L., P. Selznick, and D. Broom-Darroch, 1981. Sociology (7th ed), New York: Harper and Row.

Caiden, N., and A. Wildavsky, 1974. Planning and budgeting in poor countries. New York: Wiley.

Callon, Michel, 1980. Struggles and Negotiations to define what is Problematic and what is not: the Sociology of Translation, pages 197-219. In: Karin D. Knorr, Roger Krohn, and Richard D Whitley (eds), The Social Process of Scientific Investigation: Sociology of the Sciences Yearbook, 4, Dordrecht and Boston, Mass.

Callon, Michel, 1986. Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of Saint Brieuc Bay, pages 196-233. In: John Law (ed.), Power, Action and Belief: a new Sociology of Knowledge? Sociological Review Monograph, 32. London: Routledge.

Credé, Andreas and Robin Mansell (eds.), 1998. ITCs in Developing Countries. Booklet I: The Importance for Sustainable Development. The Hague: IICD.

Coleman, J. S., 1976. Community disorganization and urban problems, in: Merton, R. K. and Nisbet, R. A. (eds), Contemporary social problems (4th ed). New Yoek: Harcourt, Brace and Jovanovich.

De Man, W.H.Erik, 1988. Establishing a geographical information system in relation to its use; a process of strategic choices. *Int. Journal of GIS*, Vol. 2, 3, 245-261;

De Man, W.H.Erik, 2000. Institutionalization of Geographic Information Technologies: Unifying Concept? *Cartography and Geographic Information Science*, Vol. 27, 2, 139-151.

De Man, W.H.Erik and Willem van den Toorn, 2002. Culture and the adoption and use of GIS within organisations. *Int. Journal of Appl. Earth Observation and Geoinformatics* (*JAG*), 4, pp. 51-63.

De Swaan, A., 2001. Words of the world: the global language system. Cambridge/Oxford: Polity Press/Blackwell Publishers.

Douglas, M., 1978. Cultural Bias (Occasional Paper no. 35. Royal Anthropological Institute of Great Britain and Ireland).

Frissen, P., 1999. De lege staat (in Dutch; the empty state). Amsterdam: Nieuwezijds

Graham, Stephen and Simon Marvin, 2001. Splintering Urbanism; networked infrastructures, technological mobilities and the urban condition. London: Routledge.

Groot, Richard and John McLaughlin, 2002.Geospatial data infrastructure; concepts, cases and good practice. Oxford: Oxford University Press.

Hardin G. 1968. The tragedy of the commons. *Science*,162:1243-48.

Hofstede, G., 1980. Culture's Consequences: International Differences in Work-related Values. Beverly Hills CA.: Sage Publications.

Hofstede, G. H., 1997. Cultures and organizations: software of the mind. New York: McGraw-Hill.

Law, John, 1992. Notes on the Theory of the Actor-Network: Ordering, Strategy and Heterogeneity. *Systems Practice*, 5, 179-393.

Law, John, 2000. Networks, Relations, Cyborgs: on the Social Study of Technology (draft, http://www.comp.lancs.ac.uk/sociology/soc042jl.html).

Law, John and and Annemarie Mol, 2002. And if the Global Were Small and Non-coherent?. Centre for Science Studies at the Department of Sociology, Lancaster University at http://www.comp.lancs.ac.uk/sociology096jl.html (version: nokia4; 28 January, 2002).

Lesser, E.L. and J. Storck, 2001. Communities of practice and organizational performance. *IBM Systems Journal*, Vol. 40, No. 4, 2001.

March, J. and J. Olsen, 1989. Rediscovering institutions; the organizational basis of politics. New York: The Free Press.

Martin, E. W. 2000. Actor-Networks and Implementation: Examples From Conservation GIS in Ecuador. *International Journal of Geographical Information Science*, 15(8): 715-738.

Merton, R.K., 1976. The sociology of social problems. in: Merton, R. K. and Nisbet, R. A. (eds), Contemporary social problems (4th ed). New York: Harcourt, Brace and Jovanovich.

Morgan, Gareth, 1997. Images of organization. Thousands Oaks, Ca.: Sage Publications.

North, D., 1990, Institutions, institutional change, and economic performance, Cambridge: Cambridge University Press.
Ostrom, Elinor, 1990. Governing the commons; the evolution of institutions for collective action, Cambridge: Cambridge University Press.
Ostrom, Elinor, 1999. Coping with Tragedies of the Commons. *Annual Review of Political Science*, 2:493- 535.
Ostrom, Elinor, 2000. The Danger of Self-evident Truths. *PS: Political Science & Politics*, 33(1) (March): 33-44.
Pickels, J. (ed), 1995. Ground truth; the social implication of geographic information systems. New York: The Guilford Press.
Robertson, Ian, 1982. New York: Sociology.
Schein, E. H., 1985. Organizational Culture and Leadership: a Dynamic View. San Francisco: Jossey-Bass.
Sheppard, E., 1995. GIS and society: Towards a research agenda. *Cartography and Geographic Information Systems*, Vol. 22, pp. 5-16.
Smith, M. K., 2003. Communities of practice. *The encyclopedia of informal education*, www.infed.org/biblio/communities_of_pratice.htm. (Last updated: 24 January, 2004);
Star, Susan L. and James R. Griesemer, 1989. Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19: 387-420.
Thompson, M., R. Ellis, and A. Wildavsky, 1990. Cultural Theory, Boulder: Westview Press.
Uphoff, N., 1986. Local institutional development; an analytical sourcebook with cases. West Hartford, Conn.: Kumarian Press.
Wenger, E., 1998. Communities of Practice; Learing as a Social System (Published in the "Systems Thinker", June 1998). http://www.co-i-l.com/coil/knowledge-garden/cop/lss.shtml. (Accessed February 25, 2004.)
World Bank, 2002. Building Institutions for markets, (The World Development Report 2002). New York: Oxford university Press.
Zijderveld, Anton C., 2000. The Institutional Imperative; the interface of institutions and networks. Amsterdam: Amsterdam University Press.