The Footprints Project: A Conceptual Project to Integrate Historical and Traditional Ecosystem Knowledge as "Expert Texts" into Multi-Scalar Ecosystem Conditions Assessment

By David Biggs

Understanding the dynamics linking human actions and environmental change at local and global scales is perhaps one of the most complicated scientific challenges in the present. It is forcing teams of scientists to communicate across disciplinary boundaries, and it is forcing some to consider the more complicated cultural and political boundaries that have historically separated formal scientists from farmers, remote indigenous groups, fishermen, and other "experts" who live intimately within their local surroundings. This Millennium Assessment Conference is one such attempt to build new approaches to these problems, enabling researchers to continue grappling with ways to integrate other kinds of environmental knowledge.

Sociologist Bruno Latour argues that "ecological thinking"—the consideration of a problem within multiple natural and social contexts—will ultimately bring about a shift in notions of political and economic interaction.[1] Ismail Serageldin conveyed a similar notion when he referred to the additional role of "social and cultural capital" within a

[1] Bruno Latour. "To modernize or to ecologize? That 's the question," in N. Castree and B. Willems-Braun, Eds. *Remaking Reality: Nature at the Millenium*. London and New York: Routledge (1998). Ismail Serageldin is the Director of the Bibliotheca Alexandrina and has published extensively on issues of development, water politics, and poverty and his published books include *Nurturing Development* (1995), *Sustainability and the Wealth of Nations* (1996), *Architecture of Empowerment* (1997), *Rural Well-Being: From Vision to Action* (1997, with David Steeds), *The Modernity of Shakespeare* (1998), *Biotechnology and Biosafety* (1999, with Wanda Collins), *Very Special Places* (1999) and *Promethean Science* (2000, with G. Persley).

reformed economics in his opening remarks for this conference. Both of these men recognize the transformative power of such re-conceptualizations of political and economic exchanges. They would fundamentally alter ways that corporations and governments as well as individuals assess their gains and losses; and they would alter terms of corporate and individual liability to communities where losses of these other forms of capital—social, cultural or natural—occurred.

As an environmental historian interested in preserving knowledge of the environmental past, especially that gained through farming and lived experience, I am especially interested in the integration of local knowledge into scientific models and dialogues on ecological assessments. I'm also interested in the implications of such ventures with respect to local communities. The Scientific Revolution in Europe was an "age of discovery" as well as an age of war, with both civil wars, religious wars, and wars of conquest across much of the Americas, Asia and Africa. We are still sorting out the philosophical implications of the Scientific Revolution in our universities, in the Global South, and especially in more remote, rural areas of the planet.

The goal of "bridging epistemologies and scales" suggests might lead to a kind of "paradigm shift" in scientific theory and more broadly into modern society.[2] Linking the term "paradigm shift" to this project is important because it reminds us that *real* change in science and politics generally occurs over rather long historical periods, usually beyond the life or career of any single person. With a historian's hindsight, I try to imagine a world with "cultural and social capital" and "ecological thinking" emerging in

[2] Thomas S. Kuhn. *The Structure of Scientific Revolutions* (1962).

fits and starts over the next few centuries—no doubt not resembling what I imagine it to be and not happening in any deep sense until well after my own life's end. Between now and that time, we are left to use the leftover tools of the Enlightenment to begin building a work that will not reproduce an Enlightenment framework. It is with this concern of getting to a more profound basis from which to begin this new scientific revolution that allows us to easily cross epistemologies and scales that I have come up with the concept of the Footprints Project.

Figure One: A Few Kinds of Footprints: (Left) 5000-yr-old Human Footprint | Beach at Fornby Pt, Lancashire | http://www.eyes-and-ears.co.uk/pennine/footprints.htm (Right) Meteorite Impact Crater | 1.13 km-diameter Tswaing Crater in South Africa | http://www.saao.ac.za/~wgssa/as2/reimold.html

The Footprints Project is an idea to build a more long-term shift in "ecological thinking." First, I do not wish to confuse my term "footprints" with the popular term "ecological footprint" used as a measure of consumption in terms of space on the Earth's surface required to produce the requisite amount of energy. Instead I prefer the more common, less technical idea of a footprint representing an event of spatial and temporal dimensions that alters or disrupts existing environmental processes and may or may not point to

related historical or cultural events. (Figure One) By building a library of "expert texts" describing specific "footprints" and their multiple contexts—spatial, historical, cultural, temporal, etc—the goal of this project is to begin building a world in which students and today's scientists could begin exploring new connections between different locations on the Earth, across different scales of time and space, and across different knowledge communities.

Using readily available technologies to extend the access of the Footprints Project to as wide a population of users as possible, this expert knowledge system would rely upon several key ingredients: assessments entered in a readable text format, an internet-based web interface for searching and adding each "footprint" text, and GIS tools to spatially reference these texts and navigate to specific locations on the Earth's surface as well as supplement the texts with available digital imagery. This would follow along the lines of recent Digital Earth projects, but the definition of suitable environmental data would reach far beyond the somewhat narrow epistemological bounds of remote sensing to include oral histories, expert summaries of relevant physical or archival sources, and other information contributed by experts within any given field. By expanding the pool of "experts" beyond boundaries of media or the dominance of the English language, the Footprints Project would allow a much wider participation in ecological assessments.

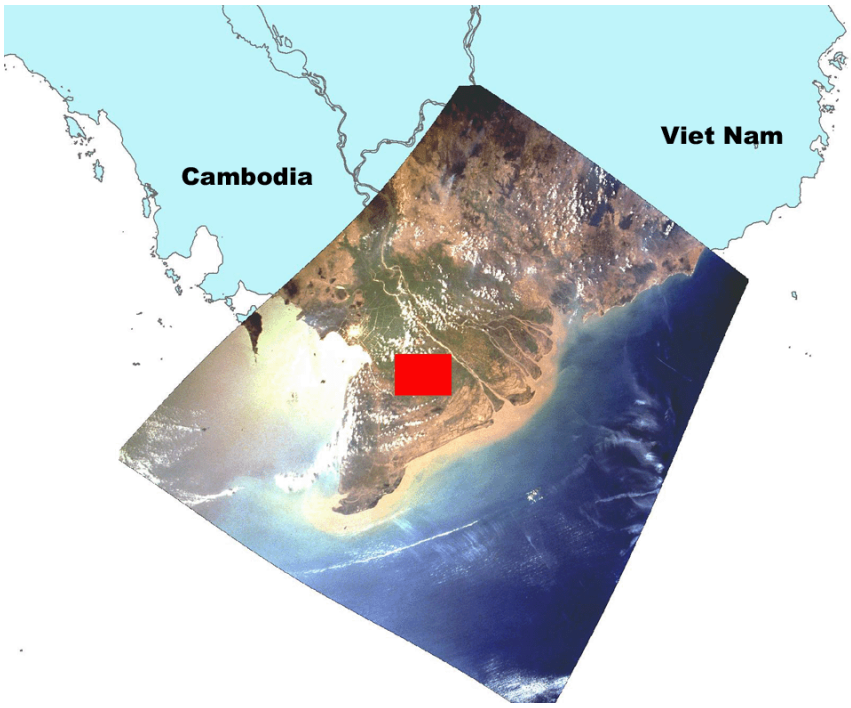


Figure Two: Study Area in the Mekong Delta, Vietnam. The underlying space photograph of the Mekong Delta is courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center (Image Record STS075_STS075-721-47). The original image was transformed using a third degree polynomial transformation and geo-refernced to a low-resolution coverage of the mainland Southeast Asian shoreline in UTM WGS 84 coordinates using Erdas Imagine 8.0 software.

I began exploring the idea for Footprints while conducting historical research in the Mekong Delta, Vietnam. In order to understand local dimensions of historical and environmental change with regard to waterways in the Mekong Delta, I combined an analysis of historical documents with oral histories and historic maps of the region. A GIS-based analysis of historic maps produced in 1930, 1952, 1963 and 2000 was especially useful in understanding some spatial trends related to the Indochina Wars—degradation of canal networks, expansion of secondary wetlands caused by abandoned fields, etc. Armed with the maps and historic documents written by colonial and post-colonial engineers, I proceeded to visit the local area by motorbike and boat. Walking

through marshy trails of one secondary wetland area and talking with one local botanist and an accompanying older farmer, I realized that the maps and documents provided only the narrowest of windows into this complex local environment. First, the botanist helped me "read" the physical landscape more carefully by noting indicator plant species that suggested different water levels, soil conditions, flood regimes, etc. Second, the elder farmer helped "educate" me about the complexities of environmental and historical experiences here in a region complicated by a war lasting more than 30 years and involving intensive bombardment and bloodshed. When talking about soils, my farmer colleague was also quick to note more minute distinctions in alum and acidity levels than described in the ecological literature.[3]

My own experiences participating in this localized dialogue prompted me to think about how such dialogues happening at sites around the world in social ecology, environmental history, and even the MA sub-global assessments might be preserved for the benefit of a much wider audience. The volume of information exchanged on the Internet has increased exponentially since 1994, especially in less-developed nations since 1998; but there is not as yet any widespread attempt to build a web of "expert information" on a global scale that could support future collaboration in environmental research and learning. I believe that what I am proposing is the construction of a new kind of

[3] This local analysis is included in Chapter Six of my dissertation (forthcoming). *Between the Rivers and Tides: A Hydraulic History of the Mekong Delta: 1820-1975*. PhD Thesis, University of Washington (2004). In conversations with colleagues, especially those working in resource management, I also found ways to contribute knowledge I had gained from archival research about past trends in land use and hydraulic engineering. Colonialism and war had resulted in nearly fifty years of records and historic topographical maps lying mostly inaccessible in French and American archives and in French and English language. I would especially like to recognize and thank the faculty and staff of the Department of Environmnetal Management and Natural Resources and of Can Tho University for their assistance during the course of my research in the Mekong Delta.

Alexandria Library built with today's building blocks – information technology, texts, and rudimentary GIS tools. This digital library would expand the boundaries of expert data beyond official sources—maps, books, and official records—to include broader sources of environmental information contributed and accessed by a greater population of people than those able to enter a physical library at present. As an internet-based library, the Footprints Project would be open to any browser with an Internet connection, something often far cheaper to attain even in poor countries than transportation to Alexandria or a university library.

The remainder of this conceptual paper will attempt to outline some details about what such a digital, world-spanning library of expert text "footprints" might look like—assume for a minute that we have unlimited funding, time and institutional support for such a venture, a nice thought... I'll use my study area in the Mekong Delta as a starting point for this construction, since I am familiar there with local sources. As a starting point, I propose that Footprints use two constructs, text and a grid-space of 1-km resolution to locate texts describing events at multiple scales with a minimal resolution of 1-km square. At a 1-km grid resolution, approximately 509.6 million cells would cover the entire planet and 148.3 million would cover most of the land surfaces. Given today's computing power and digital storage of text files, it is conceivable that texts describing all 148.3 million square kilometers of land could be feasibly entered (Figure Three).

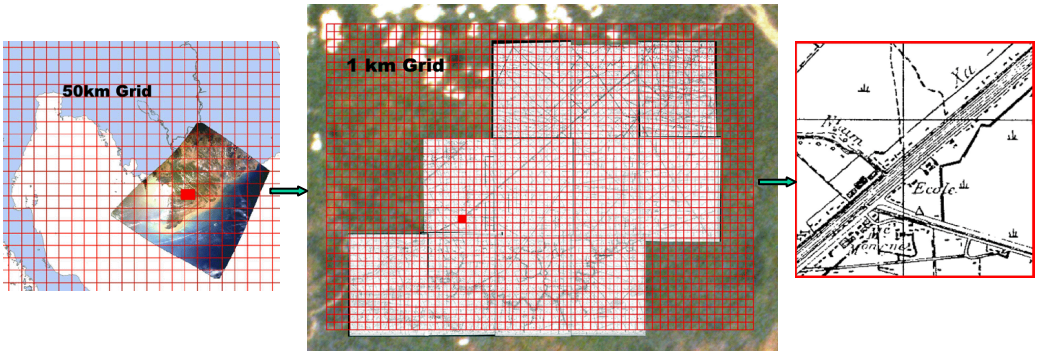


Figure Three: 50-km and 1-km Grid Overlay with 1952 Historic Maps. The above images show the general location of a study area approximately 2200 square kilometers in area. One sample cell from this grid is indicated to the right, showing an image from a geo-referenced 1952 topographical map of the region.

First, why focus on "soft texts" instead of "hard data"? While text does not necessarily convey quantifiable accuracy comparable to data sensed remotely through some instrument, it offers informational advantages. As a narrative, text blends social and natural phenomena with metaphors and analogies that often convey complex interplay in time, space, and substance. The text transcribed and translated from an oral history interview about changes at one waterway junction help illustrate the importance of narratives and stories in pointing to often complex political underpinnings of a changing physical environment (Figure Four). Text may be translated and read in multiple languages, allowing versions in vernacular sources as well as world languages such as Chinese, Spanish or English. The now widespread use of 16-bit and 32-bit Unicode character maps allows computer programs to represent characters from most of the world's major languages, and with 64-bit fonts this should capture most known language symbols. Text files also require less file space than raster graphics to store. Today's Internet search engines and web crawlers now easily build searchable databases from text files, allowing for complex searches and linkages of information, even in multiple

languages. Reading and processing of text is also comparatively much easier for older machines than viewing high-resolution graphical data that require the fastest graphics and the largest memory.

"Vậy là 1943 nó trở lại máy dầm, nó múc vô tới Cầu Trắng rồi bắc cái càu xong nó kéo Xáng Nãng [Nantes] vòng xuống Cầu Xáng, nó múc trở ra. Vây kinh Xáng mới này hoàn thành năm 1944. 1945 có giặc, ngýời ta Đông Khởi, Cách Mạng. Vây gọi tắt ngã tý này, ngã tý này gọi tắt là ngã tý nhà máy cháy. Tức là Pháp cất nhà máy lớn, sáu khối, lớn lắm. Nhýng 1945 mình nổi dậy ðập phá nhà máy, mình ðào xới lấy cừ, bây giờ gọi tắt là nhà máy cháy."	"In 1943, they returned with their dredges, and they dug to Trắng Bridge; then after they made Trắng Bridge, they sent the dredge "Nantes" down to Xáng Bridge, and then dredged back here. This canal was finished in 1944. In 1945 the enemy soldiers returned, we rebelled, and the Revolution started. We then called this intersection "burned factory junction". The French had built a big factory there, with 6-ton capacity, very big. In 1945, we rebelled and destroyed the factory, even dug up the floor, and now we call it 'burned factory junction'."

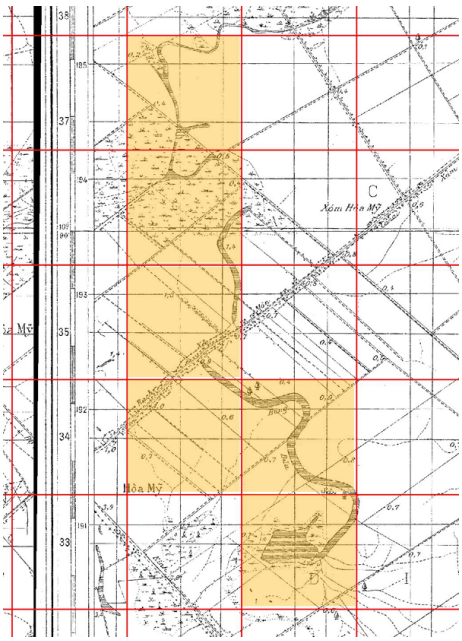
Figure Four: Sample text in Vietnamese (Left) and English (Right). The above description was excerpted from an oral history interview with one 80-yr-old farmer living at this site within my local study area. The font used in this digital format uses a 16-bit Unicode format.

Finally, reading text (or listening to someone else read it) is something that most humans can enjoy at the present; the same cannot be said for maps, data or graphics. Given an average adult's existing vocabulary of twenty to thirty thousand words and phrases, text allows a more ready (though not transparent) transmission of ideas across all manner of cultures and epistemologies. Those who do not understand maps may already possess a rich environmental vocabulary—and thus the tools that allow them to begin exploring complex ecological issues with others. I am not suggesting that texts replace geographic imagery or scientific data by any means, but I believe that it can bridge an important gap by including non-scientific environmental knowledge into a format that could inform future modeling efforts while simultaneously bringing local communities into this scientific venture.

The second major question in my conceptualization of Footprints is **why use a grid?** Anthropologists often point to the colonial implications of grids used in mapping, measurement, and land construction—events that have historically led to dislocations of indigenous people and the often-violent expansion of industrial societies into "new frontiers".[4] While this is historically true for many areas of the world, there is nothing inherently wrong with grids; while they do not usually use maps and GPS units, many farmers and "non-scientific" people use grids in everyday assessments of agricultural productivity.

Working with a common reference grid-space offers a convenient way to geo-reference texts during the text entry process. (See Figure Five.) Using a GIS-empowered interface built into a public and free web interface, a contributor could request information or define a feature by selecting cells on a grid. Geo-reference for a text could obviously occur on a much finer scale than 1-km cell and then be up-scaled to fit within the 1-km grid, but at the present time working with a 1-km grid is conceivable given today's computer technology.

[4] One often cited critique that makes this point about the "colonial grid" is Benedict Anderson's chapter "Census, Map, Museum" in *Imagined Communities*. London: Verso (1991).



Rach Bau Sau

Oxbow swamp, remnant of Bau Sau Creek that was cut after first construction of Nang Mau Canal in 1908. Now also separated by levees supporting National Highway 31. Local sources describe the lower region of the oxbow in 1952 as a rich local habitat for various anadromous catfish migrating from Tonle Sap, Cambodia.

Source

Jamme. "Amenagement Hydraulique des Provinces de Rachgia et Baclieu: Regions de U-Minh: Note No. 2253/D du 26 Juillet 1943." Vietnam National Archives II (HCM City). TDBCPNV Folio H62/6

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Figure Five: Example of a Grid Space and a Selected Environmental Feature: The selected grid cells provide a basic geo-reference for one sample text entry. The text entry is also organized into several fields including title, description, source information, and geographical coordinates of the center-point in each cell. Such fields are common in bibliographic databases such as the Dublin Core and a similar protocol now exists for labeling geo-referenced raster imagery called GeoTIFF. See "Dublin Core Metadata Initiative" at http://dublincore.org/. See "GeoTIFF" http://remotesensing.org/geotiff/geotiff.html.

Grids also offer an important visual interface for representing search results at a local and global scale. If a user searched for a term by selecting an area or by searching with keywords, a results window could show the results within a variable scale from a 1-km grid to something more global such as a 100-km grid space. Grids allow easy geo-referencing of texts; they can be used to show search results geographically at the global or sub-global scale; and they can be used to select all referenced texts for a selected region of cells at the sub-global scale. (See Figure Six.) The combination of html and recent search engine technologies would allow for various enhancements of such an interface, using hyperlinks and image maps to allow seamless transitions from a results summary to more specific texts.

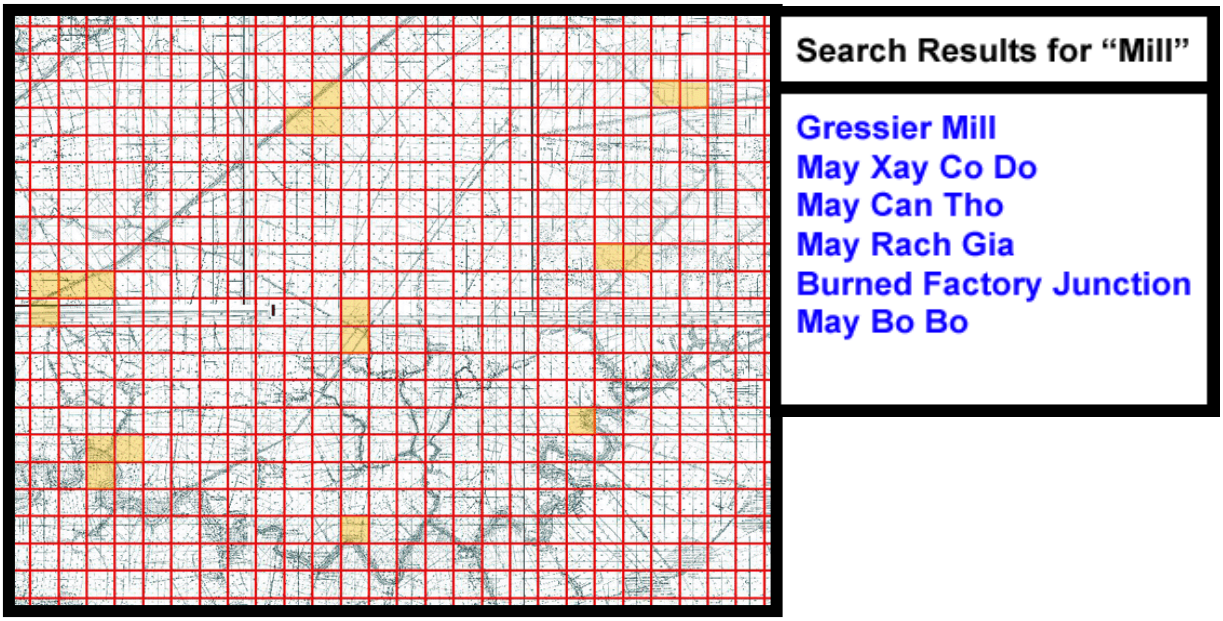

Figure Six: Graphic Showing a Results Window in a Grid (Left) and in Hypertext (Right). The above figure shows both a graphical and a textual user interface showing results for the keyword search term "mill" limited to an area of about 1000 square kilometers with an underlying raster map from 1952 topographical maps.

The third and perhaps most important question in this conceptual paper concerns the "expert contributor" and the "expert user". Knowledge is power, and it would be very important to establish limits on the depth or extent of knowledge available, hence the idea of entering in summary texts with pointers to more detailed information held locally. The process of contributing information would also involve local institutions and some procedures to verify the accuracy of these contributions. I might submit summary texts about past water conditions in the Mekong Delta and include notes indicating the source from which I made these observations and arguments; but I would not attempt to reproduce those texts in their entirety. For this, individuals would need to coordinate copyright, reproduction, and acquisition from the owning archive. A similar principle should exist for local knowledge. Locals could summarize their knowledge for general

educational enrichment; all detailed inquiries would depend on local conventions of exchange and jurisdiction. This concept of opening up the contribution and reading of entries to a broad range of people is perhaps the most radical concept in Footprints, and must be considered carefully. What is at stake are the ethics and power differences in the exchange of local indigenous knowledge with remote or state knowledge. With regard to the concepts of "social and cultural capital", Footprints would only point to rich sources, not exploit them by putting knowledge bases into text and online.

An "expert text" would be an expert summary rather than a duplication of the full text. This would allow two things. First, it would allow researchers to quickly scan diverse ideas and sources in understanding human dimensions of environmental change within a given area. In an era when humans are bombarded with "too much information" it is important to "separate message from noise" and tailor the type of information to the goals of research. Summaries would also protect the owners of a knowledge source, allowing them opportunities to negotiate with outsiders, perhaps even generating income through a fair exchange and non-disclosure agreements.

I will conclude with several issues that I hope to address in future dialogues. What is crucial for the success of such a project is the free flow of information across boundaries, scales, and cultures. Only by having more open access and participation in an information exchange can expert contributors and expert users create a new form of environmental library that can support the scientific revolution in "ecological thinking" that I have framed here in no humble terms. Building this raises obvious political and

technical questions. In subsequent discussions, I would like to explore such questions as the free exchange of geo-referenced information within acceptable bounds of politically and ethically feasible practice? Issues of hardware and software are also of key importance. I suggest that all software components developed for Footprints be open-source and GNU Public License following recent trends with Linux to afford greater public access and greater integrity in the computer infrastructure upon which such a library could be built. Understandably, such a project might be served from multiple sites around the world, also raising issues about administration of such a network. Operating servers and individual client machines requires expenditures of cash from somewhere, and a requisite electrical and fiber-optic grid. There are also questions about the financial and administrative organization of such a venture. Given the stated goals of this project, how might it be organized and financed to ensure a long-term sustainability beyond the limits of seed money and government grants? I believe that a primary system of footprints information could support profitable secondary applications such as thematic search engines and internet spiders tailored to search for specific kinds of information.