

**Transborder City-Regions and the Quest for Integrated Regional Planning:**  
Challenges posed by disarticulated infrastructures, fragmented ecologies of knowing, and uneven development

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## Abstract

This paper examines barriers and bridges to integrated regional planning in *transborder* city-regions. City-regions are diverse, often conflicting, aggregations of contiguous cities, suburbs, and their environs. To improve quality of life and place in today's fast-growing city-regions requires a regional approach. However, globalization, neoliberalism and low-density urban sprawl have combined in ways that make integrated regional planning difficult to achieve. Fragmented ecologies of knowing, disarticulated infrastructures and uneven development thwart integration. There is a pressing need to build capacity for social and institutional learning, regulatory innovation and eco-efficiency in systems of production, distribution, and consumption. Along these lines, collaborative efforts to build interactive regional information systems are promising. The exponential growth of computing power, connectivity and flexibility enable us to study/understand/appreciate, and potentially manage, vastly more complex living and engineered systems than was hitherto possible. However, as we argue here, integrated regionalism cannot be realized on a strictly technical or top down basis. It requires an ecology of agents whose modus operandi includes peer-reviewed science, state-society synergy, civic engagement and efforts to advance principles of social democracy. In this light, this paper draws attention to a collaborative "Regional Workbench" (RWB) program in the San Diego-Tijuana city-region. The RWB aims to create a transborder knowledge-based regional information infrastructure for sustainable development. It is a "learn-by-doing" experiment based on principles of distributed intelligence, federation, and dynamic knowledge networking. In referencing this and other cases, this paper's broad objective is to suggest an agenda for integrated regional planning in transborder settings. The paper draws together insights from discourses on globalization, new regionalism, sustainability science, knowledge management, information integration and planning support systems.

## I. Introduction

This paper begins by placing concerns about global urbanization and the question of sustainability in an integrated socio-economic, biogeophysical, and epistemological context. From this perspective, we address a series of fundamental questions re: "Knowing Why, When, & How to Act Regionally." This phrase appears as a header in the San Diego Association of Government's (SANDAG) January 2000 report titled: *Regional Accomplishments & Challenges*.

SANDAG is the metropolitan area of San Diego's regional decision-making forum and planning agency. It is governed by a Board of Directors composed of an elected official from each of the regions 18 incorporated cities, plus the County of San Diego. SANDAG'S many activities include strategic planning for public facilities financing, housing, energy, land use, growth management, open space/environmental/habitat conservation, waste management, airport land use, watershed/water quality, and shoreline erosion at a regional scale. Given how the San Diego metropolitan area has fused with the growth of Tijuana, SANDAG engages in binational collaboration with Mexico. The Tijuana counterpart responsible for binational planning is the *Instituto Municipal de Planeación* (Municipal Institute of Planning), popularly referred to as IMPlan.

The San Diego-Tijuana transborder city-region provides a good case for examining barriers and bridges to integrated regional planning in a transnational setting. However, this paper does not present a case study as such. Rather the intent here is to highlight salient issues and provide a conceptual framework for thinking about what to do. The paper concludes by outlining a crucial role for research universities. Universities are well positioned to strike up innovative partnerships for the kind of knowledge creation, integration and sharing necessary for effective regional planning and, ultimately, sustainable development. Six broad, interrelated points orient the analysis and frame the papers main argument.

### 1. RESOURCE-INTENSIVE INDUSTRIALISM AND RAPID URBAN-DEMOGRAPHIC GROWTH HAVE BECOME LARGE-SCALE BIOGEOPHYSICAL FORCES ON EARTH.

Human activity is significantly altering many of the planet's life support systems and material cycles including the atmospheric system and the carbon, nitrogen, sulphur, biologic and hydrologic cycles.<sup>1</sup> The sheer magnitude of this fast expanding "ecological footprint" has raised concerns about the status of economy-environment interdependencies. Many scientists and policy-makers now argue that we are in a race against time to equitably bring our global patterns of production and consumption into concert with the *carrying capacity* of regional and global ecosystems; that is, with the earth's capacity to regenerate the raw material inputs and absorb the waste outputs of the human economy. This is the so-called challenge of "sustainable development,"-- commonly defined as development that meets the needs of today's generation without diminishing the ability of future generations to meet their own needs. Integrated regionalism would be grossly incomplete without a solid grounding in principles of sustainability.

**2. GLOBAL URBANIZATION AND UNEVEN DEVELOPMENT COMBINE IN WAYS THAT MAKE TRADITIONAL PLANNING AND POLICY APPROACHES PROBLEMATIC**

City-regions are diverse, often conflicting, aggregations of cities, suburbs, and their environs that need to be organized as integrated systems composed of communicating networks of infrastructures. Yet globalization, neoliberalism and low-density urban sprawl have combined in ways that make traditional planning and policy approaches problematic. There are contradictory views about such fundamentals as capital mobility, trade, state intervention, and metrics for measuring wealth and quality of life. Fragmented ecologies of knowing, disarticulated infrastructures and uneven development thwart integration. Such contradictions become all the more apparent in transborder city-regions—which presents both constraints and opportunities.

**3. THE GLOBALIZATION OF CAPITALISM IS GIVING RISE TO A NEW REGIONALISM.**

City-regions have gained importance as territorial agents in the in the world economy's new competitive landscape. City-regions are the middle ground tying together local and global forces; they are nodal points in globe-girdling networks of consumption, production, distribution and exchange. From a conceptual and practical standpoint, city-regions (as distinct from nation states) are important testing grounds for integrating the three Es of sustainable development: economic efficiency, equity, and environmental stewardship.

**4. RISING INTEREST IN SUSTAINABILITY AND INTEGRATED SYSTEMS REFLECTS A MORE ECOLOGICAL APPROACH TO KNOWLEDGE CREATION, INTEGRATION AND SHARING.**

Across a wide range of fields, understanding how knowledge gets created, integrated, and shared is dramatically changing. These epistemological shifts--broadly defined here as movement towards more ecological approaches to knowledge production and management—are evident in academic domains including the social, natural, and life sciences; the humanities; and computer science and engineering. It is also evident in professional domains involving business, government, and non-profit organizations. As an interdisciplinary field, the planning profession can leverage emergent ecologies of knowing to develop and draw together the kind of planning support tools, integrated science and knowledge networks necessary for sustainable development. Of course, this kind of concerted action (holism) doesn't happen automatically. Besides funding, measurable progress towards sustainable development requires the creation of new forms of social, cultural, and intellectual capital (multidisciplinary knowledge and wisdom). It also requires attractive incentive structures and institutional support.

**5. THE REVOLUTION TAKING PLACE IN INFORMATION AND COMMUNICATIONS TECHNOLOGIES (ICT) EMBODIES A SPATIAL PARADOX: IT UNITES AND DIVIDES AT THE SAME TIME**

As a growing number of analysts point out, electronics-based networks segregate as much as they connect, and they do so selectively (there are serious digital divides within as well as across regions and nations). While sustainable development may require long-term integrated planning, partnerships, and coordinated action, it must also rely on the use of ICT to promote collective goals of accessibility, accountability, transparency, efficiency, and equity.

**6. “REGIONAL WORKBENCHES” CAN SYNERGISTICALLY ENABLE RESEARCH, EDUCATION AND OUTREACH IN THE QUEST FOR INTEGRATED REGIONAL PLANNING AND SUSTAINABLE DEVELOPMENT.**

The development of advanced computational infrastructure should go hand in hand (co-evolve) with new forms of participatory governance committed to peer-reviewed science, civic engagement, state-society synergy and efforts to advance principles of social democracy. At the heart of this challenge is the task of strategically reaping benefits through distributed intelligence, federation, dynamic knowledge networking and collaborative learning. Research universities can play an important role in this regard, for instance, by developing what we describe in this paper as a *Regional Workbench*---a collaborative, web-based network for sustainability science, regional ecology and the linkage of knowledge to action.

**II. Global Urbanization, Uneven Development and Transborder City-Regions**

Our species was on earth a million years before it numbered 1 billion people. That was at the turn of the 19th Century. It took only 130 years to reach the second billion, 30 years to reach the third, 15 the fourth, 12 the fifth. World population crossed the 6 billion mark in 1999. This tidal swell of humanity has followed an equally impressive growth in the world economy and demands on the earth's resources. From 1900 to 1990, as the world's population multiplied more than three times, global economic output grew twentyfold, the consumption of fossil fuels grew by a factor of 30, and industrial production by a factor of 50. The great bulk of this growth, about four-fifths of it, occurred since 1950 (MacNeil, et al. 1991: 3).

Just as the world's population and global economy have grown dramatically, so too have cities. "The State of the World's Cities Report 2001," recently published by the UN, estimates that the world now has three billion urban dwellers—nearly half the people on earth. In 1950, just 29% of the world's population lived in cities. Today, there are 19 cities with 10 million or more people; 22 cities with 5-10 million people; 370 cities with 1-5 million people; and 433 cities with 0.5 to 1 million people. By 2030, the UN estimates that over 60% of the world's population (4.9 billion out of 8.1 billion) will live in cities (Habitat 2001). Most of the urban growth on earth (perhaps as much as 90% of it from 1990-2025) will be in cities in the developing world.

Global urbanization is highly uneven. Depending on the definition used, between 25 and 50 percent of the world's urban population now live in extreme poverty. While many of the world's city dwellers live in relative comfort, an estimated 600 million are homeless or living under life- and health-threatening conditions. A 1996 report published by the UN Centre for Human Settlements estimates that this figure could triple to 1.8 billion by 2025 if a revolution in urban problem solving does not take place soon (Habitat 1996). The Habitat report underscores the importance of advancing an integrated approach to planning: "The need for planning becomes ever more necessary in light of the increased social, economic, and environmental impacts of urbanization, growing consumption levels and renewed concerns for sustainable development since the adoption of Agenda 21" (cited in Low et al., 2000: 7). Calculating for the period 1990 to 2030, the World Bank estimates that the human population will almost double and industrial output and energy use will probably triple worldwide and increase six fold in developing countries. Under current practices, the World Bank warns, that the result could be "appalling environmental conditions in cities and countryside alike" (World Bank 1992: 310).

The world's urban population is growing at 4x's the rate of the rural population (World Resources Institute, et al. 1998: 146). The highest rate of urban growth on the planet is taking place in Third World cities. The number of the world's megacities (cities w/ at least 8 million inhabitants) has risen from 2 in 1950 to 23 in 1995, with 17 in the developing world. An estimated 25-50% of urban residents living in third world cities occupy squatter settlements with little or no basic services (World Resources Institute, et al. 1998: 147).

In addition to megacities, another type of global urban space we see emerging today (the subject of this paper), is what Lawrence Herzog has dubbed the "transfrontier metropolis," what we refer to here as transborder city-regions. We don't limit this term to include only large densely populated urban-regional agglomerations. So, for instance, the U.S.-Mexico border twin cities of Nuevo Laredo-Laredo, Reynosa-McAllen, and Matamoros-Brownsville, each of which have combined populations of less than 1 million people, fall within our definition of the term transborder city-regions. The term "city-region" has been around for decades. Now much attention has focused on defining so-called *global* city-regions, as compared to say, world cities and global cities (see Scott 2001, Sassen 2001).

As Herzog (2000: 130) points out, ever since the nation state first became the dominant form of territorial organization on the planet: "...cities have been understood as physical places that lie within the boundaries of one sovereign nation. Yet the late twentieth century marks a new global geography, where city-regions housing millions of inhabitants sprawl across international boundaries, most notably in Western Europe and North America." Transborder city-regions along the U.S.-Mexico border are dramatic examples where significant wealth is juxtaposed to poverty. In the San Diego-Tijuana city-region, the City of San Diego has a population approximately the same size as the city of Tijuana. Yet, Tijuana has a municipal budget one-fourteenth of San Diego's (about \$100 million versus approximately \$1.4 billion) (San Diego Dialog 2000). This has made it difficult to develop region-serving infrastructure in the San Diego-Tijuana area. Presumably, the quest for integrated regional planning in transborder city-regions poses additional opportunities and constraints as compared to global city-regions squarely within the territorial bounds of one nation. This is an empirical question that merits further study. We do not have comparative results to present along these lines; but our references to the San Diego-Tijuana case and other cases should help set the stage for further inquiry.

In our effort to locate global transborder city-regions—that is, regions experiencing pressures of globalization as well as specific development constraints and challenges related to their border location—we have explored a number of classification and delimitation methodologies. The emergence of global city-regions is reinforced by global investment, development of communication networks, increased mobility which all lead to the development of highly active global city networks with global hinterlands.

A Lincoln Institute study (1995) identified the following four major characteristics of city-regions: large population, diversified market economy, distinct patterns of growth and change, and a record of attempts by governments to shape regional form. San Diego was in the initial list of 12 cities selected for case studies by the Institute, along with 5 global city-regions from Asia, 3 from Europe, 2 from South America and 1 from Canada. Other case studies of globalization were presented at the the "Global City-Regions Conference" held in Los Angeles in 1999 which summarized theoretical and practical accomplishments in the studies of global urban networks (Scott 2001).

Beyond the common case study approach, attempts to delineate transborder global city-regions face at least two methodological problems. One is the lack of conventional definition of a global city-region, another is the common vagueness of the notion of a "border region". In the San Diego-Tijuana case, for instance, regional analysts suggest that the definition of this particular region must be flexible. In a report titled, "The Global Engagement of San Diego/Baja California" the authors note: "While the definition of our core region might be San Diego/Tijuana, or San Diego/Baja California, it grows to the east, to the north and perhaps beyond depending upon the issue being addressed. In other words, there may be multiple definitions of the term "region" when examining issues related to our future competitiveness in the global economic system" (San Diego Dialog 2001)

The lack of comparable statistical data on city population at the global scale makes an acceptable statistical definition of a global city-region and its relative place in the world urban hierarchy even more problematic. Although a conventional definition of a global city-region has yet to be developed, some of the defining characteristics include the agglomeration of industry, concentration of talented workers and high-tech jobs, creation of an atmosphere of innovation, establishment of public-private partnerships and institutions, which together lead to the acquisition of competitive advantage. While these aspects are closely intertwined and mutually reinforcing, they are difficult to convert into measurement criteria for delineating global city-regions.

In this paper, we focus on those global city-regions where transnational connections overlap with intense cross-border interactions. To operationalize the definition of a transborder city-region we need to delimit a border region – which, in turn, can be done in several ways, beyond a simple assignment of a distance buffer around international border. Delimitation of a border region in terms of distance "depends on the problem(s) of interest and on peoples normal spatial behavior", as noted by Frederiksen and Hansen (2000). Whether being in a border area supports or hinders development of a city-region, depends on the role of this border, as either a barrier, or a catalyst triggering proliferation of border institutions, coordinating bodies, generating jobs, and promoting competitive advantage of the entire region. Common transborder obstacles, reviewed in this paper, are caused by the need of establishing a higher-level agreement between countries on coordinating land use, transportation, recreation etc. in the border area, different language, norms and laws regarding data access, etc.

In a recent compendium of world cities population, T. Brinkhof (2001) lists 386 principal cities and agglomerations of the world, with a population of 1 million or more. Since this effort was not specifically focused on identifying potential transborder global city-regions, we developed our own count based on the European GRID-Arendal data collection. Using this data set we identified 136 cities over 100K located within 10 miles from an international border. Of this set, five are urban agglomerations populated by 1 million or more people. Not surprisingly, the highest concentration of near-border large cities is in Europe, where transborder integration has long history. Ten of the cities are along the US-Mexico border, area of our interest. While this simplified geographic delineation does not take into account industrial and high-tech agglomeration, concentration of communication hubs and other factors mentioned above, it allowed us to at least identify the number of potential areas of high-intensity cross-border interactions within urban environments. Unfortunately, the European GRID-Arendal data collection is outdated; most of the population figures are at least a decade and half old; some date back 20 or 30 years.

Another less reliable, although more current, source of population data (rounded to 100K) is provided by the United Nations Development Program (UNDP). The UNDP data set includes urban agglomerations of 1 million population or more in 1996. The UNDP defines the concept of agglomeration as "the population contained within the contours of contiguous territory inhabited at urban levels of residential density without regard to administrative boundaries." (see <http://www.undp.org/popin/wdtrends/urb/furbtoc.htm>). We used this data to produce the maps shown in **Figure 1** (Large border cities in 1996), **Figure 2** (Large border cities in 2015), and **Figure 3** (Annual percentage population growth of large border cities between 1990-1995). All of these cities are within 50 miles of an international boundary (for a complete list see **Appendix 1**).

The fastest-growing transborder city-regions are located in Western Africa, Middle East and South Asia. Although rates of population growth slow down for most of them by 2015, these city-regions are some of the largest on the planet. All seven border city-regions with populations weighing in at 7 million or more, are located in Africa and Asia (Lagos, Dhaka, Calcutta, Seoul, Lahore, Kinshasa, Guangzhou). The UNDP's demographic forecasters project that by 2015 there will be 38 border agglomerations inhabited by 2 million or more people; and that 23 of these will be in Africa and Asia (the comparable figure for 1996 was 15 out of 28).

Michael Douglass (1998) has done some of the best work on city-regions and transnational city-region networking in Asia. He points out how National plans in this part of the world are replete with global designs for cities and regions, including international growth triangles such as the Tumen River Basin and Yellow Sea Rim, Hong Kong-Guangdong, Singapore-Johor Baru-Riau, and a number of lesser "triangles" such as the "Northern Triangle" connecting North Sumatra with Penang, Northern Malaysia and Southern Thailand; the Eastern Triangle covering Kalimantan (Borneo) Brunei and the Southern Philippines; and a number of Thai border towns slated to link up with sister cities across international borders (see **Figure 4**). As Douglass (1998) points out, "Each of

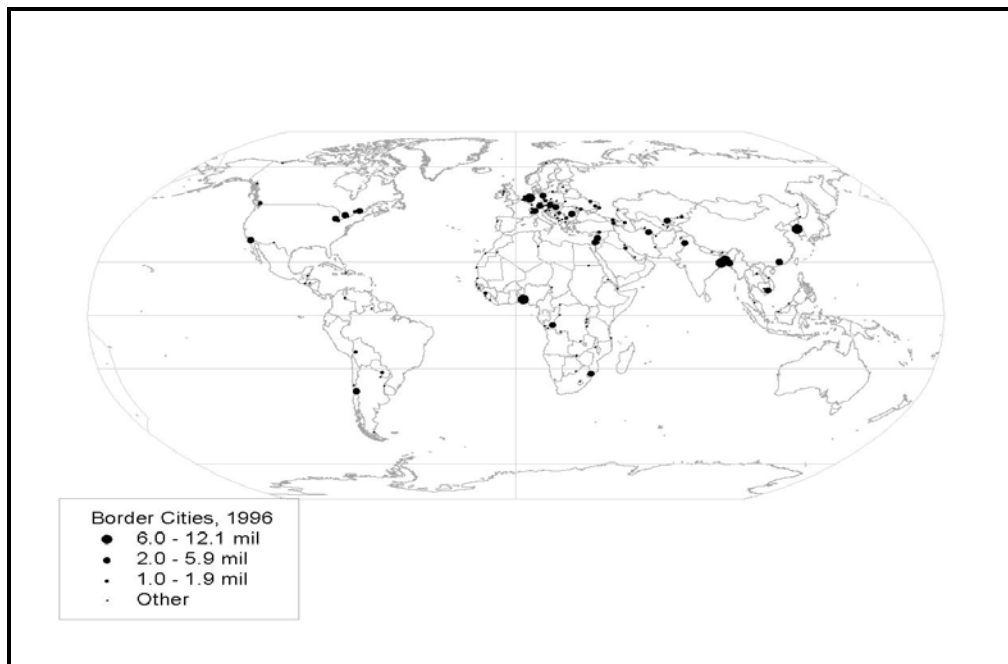
these developments entails unprecedented levels of investment both in urban regions and along corridors connecting them across national borders” (p. 112).

European transborder city-regions (with populations ranging between 300,000 and one million inhabitants) include: Basel-Mulhouse-Freiburg (Swiss-French-German border); Maastricht-Aachen-Liege (Dutch-German-Belgian border), Geneva metropolitan area (Swiss-French border); and the Strasbourg metropolitan area (French-German border). Herzog (2001) suggests that the most important and successful example of European transfrontier planning is the Regio-Basiliensis, a regional planning entity in the Swiss-German-French border region near Basel, Switzerland. More than two million people live in the trinational urbanized region surrounding the city of Basel. Over one hundred thousand commuters travel into Switzerland to work on a daily basis in this region.

Russian-speaking areas of Ukraine, with heavily urbanized coal mining areas of Donbass, meet similar heavily urbanized mining areas across the Russian-Ukrainian (now international) border. While these areas experienced a certain degree of regional planning coordination during the Soviet times (at the level of the General Settlement Scheme for the Territory of the USSR, and schemes of regional planning), in the current period of restructuring transborder urban planning has come to a virtually halt. As to regions of eastern Europe, recent boundary changes and political instability do not support much in the way of transborder planning their either.

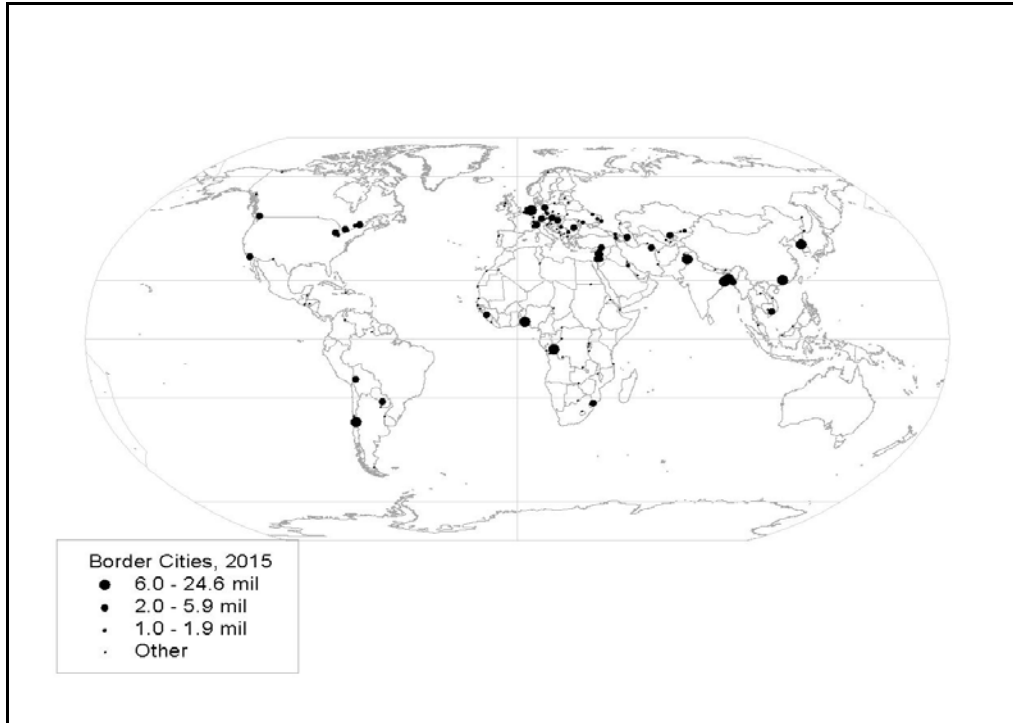
Transborder city-regions concentrated along the Canadian border of the US include Detroit-Windsor, the Buffalo-Niagara area, and the Vancouver-Seattle-Portland axis. The U.S.-Mexico border region, which extends 2000 miles from the Atlantic to the Pacific coast, is shared by two nations, ten states (four in the U.S. and six in Mexico), and 64 municipalities (39 in Mexico and 25 in the U.S.) (see **Figure 4**). There are fourteen “twin city” pairs in this jumble of political jurisdictions. As Lara (2001) points out, the differences in culture, degree of development, legal structure and political systems make integrated regional planning in this area complicated.

**FIGURE 1: LARGE BORDER CITIES (1996) WITHIN 50 MILES OF AN INTERNATIONAL BORDER  
(POP = 1 MILLION OR MORE PEOPLE)**



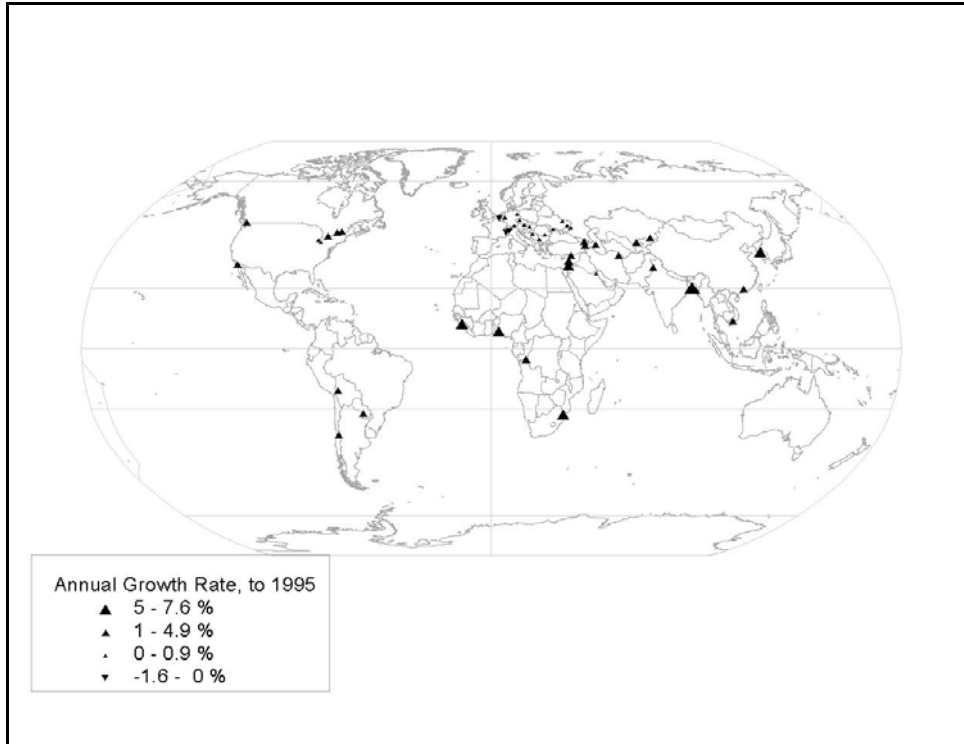
Source: Population Division of the Department of Economic and Social Affairs, of the United Nations (United Nations publication, (ST/ESA/SER.A/163), Sales No. E.97.XIII.2, Copyright (C) United Nations 1997, on the web at <http://www.undp.org/popin/wdtrends/urb/urb.htm>). The list contains 336 urban agglomerations with estimated population over 1 mil in 1996. The population data were joined to the world cities coverage available from ESRI "Data and Maps" CD Publication (1999). Source of country boundaries is also the ESRI "Data and Maps" publication (1999). The county boundaries were used to generate a new coverage of land boundaries (using ESRI's Arc/Info) and create 50 mile distance buffers around them (using ESRI's ArcView GIS), to develop a list of urban agglomerations with close proximity to international borders. For this reason, the title of this map reads border cities, not transborder cities. Not all these cities currently span an international border.

**FIGURE 2: LARGE BORDER CITIES (2015) WITHIN 50 MILES OF AN INTERNATIONAL BORDER  
(POP = 1 MILLION OR MORE PEOPLE)**



Source: Population Division of the Department of Economic and Social Affairs, of the United Nations (United Nations publication, (ST/ESA/SER.A/163), Sales No. E.97.XIII.2, Copyright (C) United Nations 1997, on the web at <http://www.undp.org/popin/wdtrends/urb/urb.htm>). The list contains 336 urban agglomerations with estimated population over 1 mil in 1996. The population data were joined to the world cities coverage available from ESRI "Data and Maps" CD Publication (1999). Source of country boundaries is also the ESRI "Data and Maps" publication (1999). The county boundaries were used to generate a new coverage of land boundaries (using ESRI's Arc/Info) and create 50 mile distance buffers around them (using ESRI's ArcView GIS), to develop a list of urban agglomerations with close proximity to international borders. For this reason, the title of this map reads border cities, not transborder cities. Not all these cities currently span an international border.

**FIGURE 3: ANNUAL POPULATION GROWTH RATE, LARGE BORDER CITIES (1990-1995) WITHIN 50 MILES OF AN INTERNATIONAL BORDER (POP = 1 MILLION OR MORE PEOPLE)**

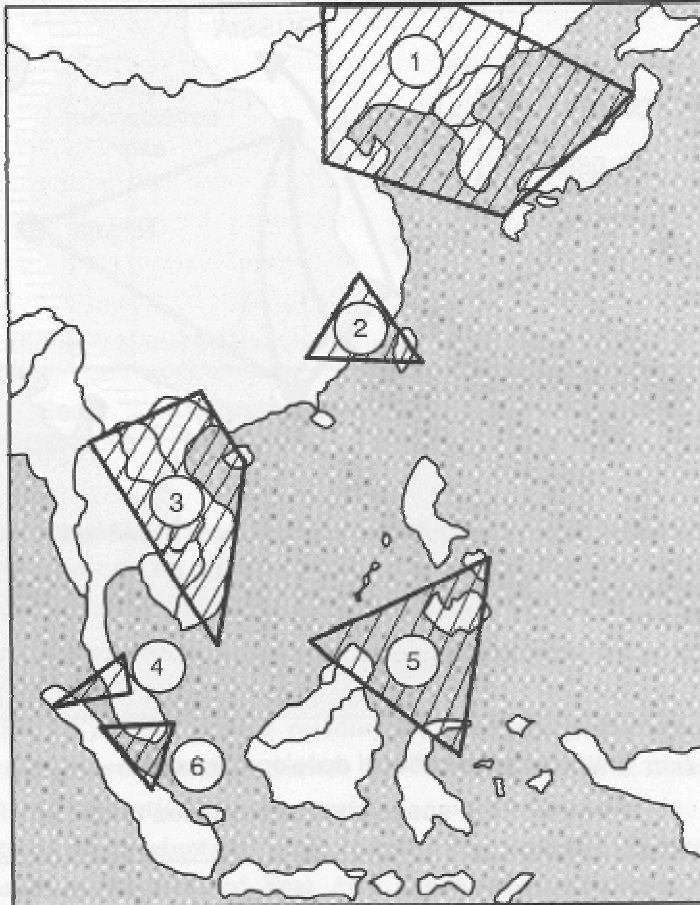


Source: same as figures 1 and 2.

**FIGURE 4: EXTENT OF CROSS-BORDER AREA (SOURCE EPA)**



**FIGURE 5. WORLD CITY FORMATION ON THE ASIA PACIFIC RIM:  
TRANSBORDER REGIONS PROMOTED BY ASIAN GOVERNMENTS, 1990s**



- (1) Northeast Asia TBR: includes Tumen River Basin: Russia, China, N.Korea, S.Korea, Japan.
- (2) Taiwan–Fujian TBR.
- (3) Mekong TBR: Vietnam, Laos, Cambodia, Thailand.
- (4) Northern Growth Triangle: Sumatra (Medan), Malaysia (Penang), southern Thailand (Songkhla/Hatyai).
- (5) Eastern Growth Triangle: Mindanao, North Sulawesi, Brunei, Sabah.
- (6) Sijori Growth Triangle: Singapore, Johor Baru, Riau.

Copied from: Michael Douglass (1998a: 113), "World City Formation on the Asia Pacific Rim: Poverty, 'Everyday' Forms of Civil Society and Environmental Management," in M. Douglass and John Friedmann, eds., *Cities for Citizens: Planning and the Rise of Civil Society in a Global Age*. (London: John Wiley), 107-137. The original figure credits Douglass (1995) and Chen (1995).

### III. Disarticulated Infrastructures and the New Regionalism

The UN's most recent publication, "Cities in a Globalizing World," documents how contemporary patterns of urban and regional growth continue to fuel uneven development (Habitat 2001). In order to secure their standing in the world's new competitive landscape, city-regions are increasingly compelled to act as integrated territorial units; yet, globalization has been increasing the fragmentation of these city-regions--socially, economically and physically. Graham and Marvin (2001) provide evidence of this in their book, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities, and the Urban Condition*. *Splintering Urbanism* documents how the dynamics of uneven global urbanization are underpinned by radical transformations of networked infrastructures, especially telecommunications, transport, energy, water, and urban streets.

Citing the work of Manuel Castells (1996, 1997, 1998), Graham and Marvin (2001) argue that "new, highly polarized urban landscapes are emerging where 'premium' infrastructure networks -- high speed telecommunications, 'smart' highways, global airline networks -- selectively connect together the most favored users and places, both within and between cities" (p 25). Those not directly plugged into these networks are disadvantaged; they find themselves on the wrong side of the so-called digital divide. And this divide is not simply digital. As Graham and Marvin (2001) point out, the unevenness of development shows up in the design of a broad range of infrastructure networks (most notably, telecommunications, transport, energy, water, and the transportation grid), "both in terms of the geographies of the points they do and do not connect, and the control placed on who or what can flow over the networks" (p.25). They sum up their view in the following terms:

Virtually all cities across the world are starting to display spaces and zones that are powerfully connected to other 'valued' spaces areas across the urban landscape as well as across national, international and even global distances. At the same time, though, there is often a palpable and increasing sense of local disconnection in such places from physically-close, but socially and economically distant, places and people..... Because of these dynamics, and the intensifying uneven development of infrastructures, physically close spaces can, in effect, be relationally severed (Graham and Healey, 1999). At the same time, globally distant places can be relationally connected very intimately. This undermines the notion of infrastructure networks as binding and connecting territorially cohesive urban spaces. It erodes the notion that cities, regions and nations necessarily have any degree of internal coherence at all. (p. 25)

In less abstract terms, the disarticulated infrastructure of uneven development translates into processes like urban sprawl, jobs-housing imbalance, all of which adds to a city-regions congestion, environmental problems and decline in quality of life/place. To the extent that public agencies target such problems, the response is typically carried out in a reactive, piecemeal fashion at an inappropriate scale.

The dynamics described by Graham and Marvin constitute powerful countervailing forces that work against integrated regional planning. But human agency is also part of this story. While the Transnational Corporations (TNCs) of today's global economy are becoming increasingly powerful, this does not mean that the fate of city-regions is determined only by distant forces beyond any form of local control. Cities and regions can be actors in their own right; they make choices. Indeed, there is a burgeoning literature in the fields of economic geography and regional planning that examines the spatial paradox of globalization. While there is ample evidence that globalization gives us "splintering urbanism" and uneven development (within as well as across regions), globalization also appears to be compelling city-regions to construct interterritorial bases of collective action and identity, including integrated regional planning (Scott 2001). A telling quote from the SANDAG report cited above (*Regional Accomplishments & Challenges*, January 2000) gives us a glimpse of this: "We are your elected representatives of local governments, and we strive to think beyond our own invisible political boundaries. We all drink from the same water supply, breathe the same air, travel on the same transportation system, use the same power sources, and enjoy this region's diverse environment. We need to think, plan, and act as a region to be competitive in today's global economy."

Michael Storper's work sheds light on the importance of territorial development and quality of place in metropolitan regional economies (Storper and Salais 1997; Storper 1997). City-regions are the locus of "untraded interdependencies"--a term economic geographers use to describe region-specific assets in production (i.e., social capital in the form of networks, conventions, informal rules, and habits). Storper stresses the strategic importance of these necessarily place-based "untraded interdependencies"

including face-to-face interaction, learning capacities, and systems of innovation. These regional assets (e.g., social and intellectual capital) constitute an increasingly important form of knowledge-based infrastructure. These insights provide an important theoretical underpinning to an emerging body of work (not without contradictions) referred to as "New Regionalism."

In his book, The Regional World: Territorial Development in a Global Economy, Michael Storper (1997) characterizes “economic reflexivity” as the central characteristic of contemporary capitalism. Storper defines economic reflexivity as “the possibility for groups of actors in the various institutional spheres of modern capitalism—firms, markets, governments, households, and other collectivities—to shape the course of economic evolution.” He does not suggest that such reflexivity is free from constraint. Rather he employs the concept of reflexivity to put the old social science debate between determinism and free will in a new light. Emphasis is placed on relationships and capacities to learn within regions as important territorial units of analysis:

Heterodox regional economics, like economics in general, continues to be controlled by the metaphor of economic systems as machines, with hard inputs and outputs, where the physics and geometry of those inputs and outputs can be understood in a complete and determinate way. This focus on the mechanics of economic development must now be complemented by another focus, where the guiding metaphor is the *economy as relations*, the *economic process as conversation and coordination*, the subjects of the process not as factors but as *reflexive human actors*, both individual and collective, and the nature of economic accumulation as not only material assets, but as *relational assets*. (Storper 1997: 28)

This emphasis on regions as places of learning, with varying *stocks of relational assets*, marks a significant departure from past approaches to regional studies. Until the early-1980s, regional development was typically viewed (within the disciplines of regional economics, development economics, and economic geography) as an outcome of exogenous political and economic processes. Regions were not viewed “as a fundamental unit of social life in contemporary capitalism equivalent to, say, markets, states or families, nor a fundamental motor process in social life, on the same level as technology, stratification, or interest-seeking behavior” (Storper 1997: 3). Since the early-1980s, however, greater attention has been paid to analyzing the region as a fundamental basis of economic and social life (Mitchell-Weaver, et al. 2000).

In this paper we are focusing on the “new regionalism” of a metropolitan sort. Steven Wheeler (2000) points out that this new metropolitan regionalism has five defining features: “1) a focus on the metropolitan region as the unit of analysis and action, 2) a renewed emphasis on physical planning, urban design, and place, 3) a broadened agenda including environmental, equity, and livability issues as well as economic development, 4) a normative, action-oriented approach aimed at addressing regional problems, and 5) a widened range of research methods including qualitative as well as quantitative tools” (p. 1). Scott (2001: 1) also characterizes what is “new” in the “new regionalism.” By emphasizing the growing significance of place-based regional assets, including the kind of untraded interdependencies noted above, Scott argues that the new regionalism stands in opposition to the view that instant communications and the global network society have made geography less relevant. Moreover, the new regionalism differs from an older regionalism with respect to how individual regions within any particular national territory today are less apt to be subservient to the dictates of the central state (Scott 2001: 2).

In the U.S., national politicians have been promoting regionally oriented policies against sprawl and for smarter growth under the heading of a “livability” agenda.<sup>1</sup> Henry G. Cisneros (the United States Secretary of Housing and Urban Development prior to Andrew Cuomo) speaks of regionalism as the key to civic life and civility. Cisneros points out the difficulties in implementing regional programs given the high degree to which local government is fragmented. Typically, regional needs are addressed through the creation of “special districts” which has complicated the issue of regional governance.<sup>2</sup> Bruce Katz (2000) argues that a combination of changes in governance, demography and markets is prompting heightened interest in regionalism in the US. The U.S. Department of Housing and Urban Development recently issued a report titled, “State of the Cities 2000: Megaforces Shaping the Future of the Nation’s Cities.” One of the reports major recommendations is based on the argument that “the answer to achieving livable communities lies in regional cooperation” (HUD 2000: xi). This position is advanced in face of evidence that

Cities and suburbs are beginning to envision a new template based on regional cooperation and joining forces to address issues that cross local jurisdictional boundaries—transportation, environmental protection, housing affordability, education, concentrated poverty, and economic development. The

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<sup>1</sup> <http://www.livablecommunities.gov>

<sup>2</sup> Cisneros (1995: 8) provides these details: “There are currently more than 33,000 special districts in the United States, and they are now the most common form of local government in the country. More than 90 percent perform a single function: 36 percent provide water and sewer services; 16 percent are fire districts; 6 percent provide postsecondary technical and vocational education and library services; 4 percent are health and hospital districts; and 4 percent perform transportation-related functions. About 11 percent are either State-chartered housing finance agencies or local public housing authorities whose activities are often limited to a single sponsoring jurisdiction.”

bottom line, local leaders are learning, is that cities need suburbs and suburbs need cities to prosper in the New Economy. (HUD 2000: xii)

It is important to note here that there is another brand of “new regionalism,” one that focuses on supranational or ‘world regions’ in the current process of global transformation.<sup>3</sup> The Bretton Woods approach to new regionalism is mainly economic with a focus on the nation state as the primary unit of analysis; it involves trade promotion policies built on regional arrangements (Cornia 1999: xiii). Other “new” regionalists are less concerned with trade per se; they explore the options of single states—especially with respect to external orientation—in the context of underlying power structures (Hettne, Inotai, and Sunkel 1999). In the Prologue to a recent five volume set on the subject, Hettne (1999: xvi) defines this brand of new regionalism as “a multidimensional form of integration which includes economic, political, social and cultural aspects and thus goes far beyond the goal of creating region-based free trade regimes or security alliances. Rather, the political ambition of establishing regional coherence and identity seem to be of primary importance.” The same author describes a half dozen ways in which the new regionalism differs from the ‘old’ regionalism. For instance, the actors driving regional projects now also include (in addition to the state) other types of institutions, organizations, and social movements. To the extent that we see this kind of integrated systems approach to regionalism, both the metropolitan and supranational (world regional) varieties of new regionalism are in sync. The epistemological shift that underpins these new theoretical perspectives is discussed further in the following section of this paper.

The point to underscore here is that all of this “regionalization,” be it driven by ecological, economic and/or socio-cultural factors, takes place at many levels of the world system: “the system as a whole, the level of interregional relations, and the internal structure of the single region (including nation states, subnational ethnic groups, and micro-regions)” (Hettne 1999: xix). For instance, given how pollution flows do not stop at political borders, the regional management of such things as hazardous wastes, acid rain, water pollution have become a strong motive force in regional integration. Such integration takes place at various geographic scales. At one extreme we see large, macro-scale initiatives such as water conservation measures in the South China Sea, Barents Sea, and South Asian River systems (Hettne 1999). At a narrower scale we see watershed-based efforts such as the The Bight of the Californias pilot project. The trilateral Commission for Environmental Cooperation (CEC) has launched the Bight of the Californias to help regional stakeholders establish cooperative partnerships that can enable ongoing regional cooperation and joint actions in the protection of marine and coastal areas. The study area includes the binational coastal region extending from Encinitas in Northern San Diego County to Ensenada in Baja California.<sup>4</sup>

The emphasis of this paper is on the prospects for integrated regional planning at the level of city-regions, with a special emphasis those that span one or more international boundaries. There are a number of reasons for selecting city-regions as the unit of analysis. As Castells and Hall (1994) have pointed out:

Precisely because the economy is global, national governments suffer from failing powers to act upon the functional processes that shape their economies and societies. But regions and cities are more flexible in adapting to the changing conditions of markets, technology, and culture. True, they have less power than national governments, but they have a greater response capacity to generate targeted development projects, negotiate with multinational firms, foster the growth of small and medium sized endogenous firms, and create conditions that will attract the new sources of wealth, power, and prestige.” (p. 7).

While there seems to be an emerging consensus that the rise of city-regions is part of a new competitive landscape worldwide, and that integrated regional approaches are needed to resolve many of the problems that negatively impact these city-regions, it is much less clear exactly what “integrated regional planning” should aim to do, or how institutions of regional governance should be constituted to do it. As one environmentalist active in the San Diego-Tijuana city-region recently put it, “regionalism is the answer, but what’s the question?” And who’s asking it? Why would a regional government provide something better? How could it? Aren’t the mechanisms considered for regional government mainly being thought of as a way to push through what the usual economic development interests want --regardless of the negative impacts? Why would regional government be any better?” (Carolyn Chase, Special to the Daily Transcript Feb. 23, 2001).

The most widely touted conceptual language that aims to answer the what, why, where and how of integrated regionalism flies under the banner of “sustainable development.” But there are many, often conflicting, perspectives among those that seek so-called “sustainable development.” The term “sustainability” has ideological and political content as well as ecological and economic content. As James O’Connor (1994: 153)

<sup>3</sup> Coleman and Underhill (1998), Gilpin (2000), Blanton (1998), Hettne, et al. (1999)

<sup>4</sup> <http://www.sccwrp.org/regional/94scbpb/94docs.htm>

points out, there is a struggle, worldwide, to determine how *sustainable development* or *sustainable capitalism* will be defined in the discourse on the wealth of nations, and we can add here the wealth of city-regions.

#### IV. Fragmented Ecologies of Knowing and the Question of Sustainability

The 1992 Earth Summit, and the subsequent City Summit (Habitat II 1996) helped draw international attention to interlocking problems of environment, development and urban management. These two global summits built on the work of the Brundtland Commission, which popularized the definition of “sustainable development” as development that meets the needs of society’s current generation without compromising the ability of future generations to meet their own needs (WCED 1987). There is now a vast, often conflicting, array of public policies, initiatives, and literature that deals with sustainability.<sup>5</sup> The 1992 Earth Summit produced a widely disseminated set of principles and action programs, including *Agenda 21*, for achieving sustainable development over the next two generations.<sup>6</sup> In the case of the U.S.-Mexico border region, there has been an impressive growth of new institutions dedicated to environmental management and principles of sustainability (notably, Border XXI, CEC, BECC and NADBANK).<sup>7</sup>

Unfortunately, a recent study completed by the UN Environment Program comes to the conclusion that sustainability initiatives have for the most part been disappointing (UNEP 1999). One can point to “best practices,” but outcomes are small, few and slow. Political problems rooted in the uneven distribution of wealth both within and across the world’s regions complicate matters. There is no consensus on what exactly needs to be sustained, how and by who. And other issues compete for the attention of decision-makers. Even when strong political will exists to advance sustainability goals, the science, knowledge and know-how to make progress is often lacking. Upon evaluating 30 strategically sampled comprehensive city and county plans in the U.S., some of which explicitly incorporated the sustainable development concept and some of which did not, Berke and Conroy (2000) come to conclusion that “the explicit inclusion of the concept has no effect on how well plans actually promote sustainability principles” (p. 30).

While the literature promoting sustainable development is huge and growing, so is the literature that finds fault in this concept for its lack of precision. The term sustainability is a good example of what Ann Markusen (1999) calls a “fuzzy concept.” James O’Connor (1994: 153) argues that the ambiguity of “sustainability” means it is, in the first instance, “an ideological and political, not an ecological or economic, question.” When all is said and done though, it seems that even those authors with a critical eye on the subject, end up suggesting that there may indeed be value in the emergent sustainability discourse. Scott Campbell (1999), for instance, argues that:

sustainability, if redefined and incorporated into a broader understanding of political conflicts in industrial society, can become a powerful and useful organizing principle for planning. In fact, the idea will be particularly effective if, instead of merely evoking a misty-eyed vision of a peaceful ecotopia, it acts as a lighting rod to focus conflicting economic, environmental and social interests. The more it stirs up conflict and sharpens the debate, the more effective the idea of sustainability will be in the long run. (p. 252)

In light of sustainability’s ambiguity, yet promise, the Policy Division of the National Research Council (NRC) convened a Board on Sustainable Development, chaired by Edward Frieman of UC San Diego. The NRC challenged this working group to come up with a plan to “reinvigorate the essential strategic connections between scientific research, technological development, and societies’ efforts to achieve environmentally sustainable improvements in human well-being” (1999: 2). At the end of their deliberations over a four-year period (1994-1998), the Board published a major report, titled, *Our Common Journey: A Transition Toward Sustainability*. They presented it at a conference attended by 80 international academies gathered to deliberate on the topic of a transition toward sustainability.<sup>8</sup> The U.S. academies involved including the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. Authors of *Our Common Journey* explain that their use of the metaphor “journey” and “navigation” is deliberate. With such language, they emphasize how any successful quest for sustainability will be a collective, uncertain and adaptive

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<sup>5</sup>The literature on sustainable development is vast and growing rapidly. For a fairly comprehensive, categorically organized overview see Pezzoli (1997a, 1997b). One can find work with an emphasis on cities (Satterthwaite 1999, Low 2000, European Commission, 1996, Pezzoli 1998, Beatty 1998, Carley and Kirk 1998); city-regions (Ravetz 2000), macro-regions (Gunderson et al. 1995); business (Hawkin et al 1999), sustainability science (NRC 1999); and radical theory (O’Connor 1994).

<sup>6</sup> See <<http://www.unep.org/unep/rio.htm>> <<http://www.un.org/esa/sustdev/agenda21.htm>>

<sup>7</sup> Herzog, Spalding, Ganster and Sanchez, Liverman et al, Ganster, Pezzoli, Institute for the Regional Studies of the Californias

<sup>8</sup> InterAcademy Panel on International Issues (IAP) Conference on the Transition to Sustainability, Tokoyo, May 15-19,2000.

endeavor that integrates strategic action and social learning.<sup>9</sup> For those steeped in the historical materialism of political economy, notions of journey and navigation may sound hollow. The NRC report does not reflect what ecological Marxists refer to as the class-based, conflict-driven, first and second contradictions of capitalism; nor does it bring into the light issues of environmental racism or other major cleavages, legacies, etc. that are deep-seated barriers to social justice and equity.<sup>10</sup> Even so, for its intended audience of scientists, governmental officials, and global institutions such as the World Bank, the report does add significant value to the discourse on sustainability.

The *Our Common Journey* report argues that we need “significant advances in basic knowledge, in the social capacity and technological capabilities to utilize it, and in the political will to turn this knowledge and know-how into action” (NRC 1999: 7). And, most importantly (with respect to the subject matter of this paper), the report identifies the region as the most useful territorial unit for organizing sustainability initiatives:

The major threats and opportunities of the sustainability transition are not only multiple, cumulative, and interactive, but also place-based. In other words, it is in specific regions with distinctive social, and ecological attributes that the critical threats to sustainability emerge, and where a successful transition will need to be based.” (National Research Council 1999: 285)

The NRC’s call for an integrated regional approach is part of a deep epistemological shift (E-shift) taking place across a wide range of fields. The E-shift can be seen in the field of urban and regional planning (as evidenced in discourses of the new regionalism, smart growth, livable communities, new urbanism, etc). It can also be seen in many fields outside of, but pertinent to, planning. The four examples briefly outlined below (from sustainability science, industrial ecology, innovation studies, medical geography) illustrate how other fields are also placing greater emphasis on ecological approaches to knowledge production and management. Our list mentions only four examples, but the E-shift is clearly wide-spread (i.e., many additional examples could be listed, for instance: new thinking in anthropology and other social sciences, the humanities, environmental engineering, molecular biology and genetic engineering, atmospheric chemistry and climate change, geology and integrated risk assessment, digital government). These epistemological shifts constitute what we refer to here as emergent *ecologies of knowing*—that is, niches of knowledge creation, integration and sharing wherein principles of distributed intelligence and federation are strategically employed in a quest for more robustly integrated systems of research and action. Right now such ecologies of knowing are still fragmented (i.e., lacking connective tissue across domains and scales). At the dawn of the 21<sup>st</sup> century, it is one of the great challenges of integrated regionalism to build such connective tissue, literally (e.g., through articulated infrastructures) and figuratively (through the powers of the imaginary evoked through such methods as integrated scenario building and visioning). Recent advances in information and communications technologies, and in our understanding of knowledge management, networking, innovation, and learning (based on principles of distributed intelligence and federation), are laying the foundation to make the necessary connections.

## Emergent Ecologies of Knowing: four brief illustrations

### 1. Sustainability Science

The new field of **sustainability science** aims to understand society-nature interactions and interdependencies from an integrated whole-systems perspective. Authors of a recent seminal article in this field argue that: “Such an understanding must encompass the interaction of global processes with the ecological and social characteristics of particular places and sectors” [Source: Robert W. Kates, William C. Clark, et al ENVIRONMENT AND DEVELOPMENT, Sustainability Science. Vol. 292 (#5517): 641 27 April 2001 <http://www.sciencemag.org/>]. The *Millennium Ecosystem Assessment* (officially launched by the UN on June 5, 2001) is a sustainability science initiative that aims to improve the management of ecosystems and their contribution to human development by helping to bring the best available information and knowledge on ecosystem goods and services to bear on policy and management decisions. The \$21 million, four-year effort will involve 1,500 of the world’s leading scientists. <http://www.millenniumassessment.org/en/>

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<sup>9</sup> In preparing this report, the authors drew on 375 reports of the NRC. They also hosted many meetings, workshops, study sessions and a public symposium (NRC 1999: Preface).

<sup>10</sup> James O’Connor (1994) *Is Capitalism Sustainable: Political Economy and the Politics of Ecology*; and J. O’Connor (1998) *Natural Causes: Essays in Ecological Marxism*.

## **2. Industrial Ecology**

In their landmark book titled *Industrial Ecology*, Graedel and Allenby (1995) define industrial ecology (IE) as “the means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continued economic, cultural, and technological evolution. It is a systems’ view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, to ultimate disposal” (p. 11). This analytic merger of industrial development with an ecological metaphor (first done by Ayres 1989) marks an important conceptual step forward. IE is ecological in that it “(1) places human activity—industry in the very broadest sense—in the larger context of the biophysical environment from which we obtain resources and into which we place our wastes, and (2) looks to the natural world for models of highly efficient use of resources, energy and byproducts. By selectively applying these models, the environmental performance of industry can be improved” (Allen, Ehrenfeld, and Lifset 1997).

## **3. Innovation Studies**

Research-based innovation in the U.S. and around the world is undergoing fundamental restructuring. Increasingly, corporations aim to innovate by developing new collaborative relationships, alliances, and partnerships; and by relying more upon their suppliers (Branscomb and Florida 1998). A series of factors are contributing to this restructuring process, including the quickening pace of technological change, the increasing knowledge-intensity of industry, and the increasingly complex relationships and interdependencies between corporations, government and university (Branscomb and Florida 1998: 22). Fountian’s (1998) study of “Social Capital: A Key Enabler of Innovation” documents how “Many firms, industries, and regions that are currently successful have formed productive collaborative relationships with a variety of other firms, laboratories, universities, and governments at both state and federal levels in order to leverage the benefits of cooperation. These benefits include shared resources, shared staff and expertise, group problem solving, multiple sources of learning, collaborative development, and diffusion of innovation” (1998: 85).

## **4. Medical Geography**

Environmental health and the life sciences are crucial fields outside planning where one sees a tighter and tighter integration of the social and natural sciences. Medical geography is just one example. A current book on this subject surveys the perspectives, methodologies, and theories that geographers use to address the subject of human health and disease. The volume includes chapters on the cultural ecology of disease; landscape epidemiology; developmental change and human health; biometeorology; disease ecology and spatial analysis in developed countries; spatial interaction in disease diffusion; and health care resources, delivery systems, and planning (Meade and Erickson 2001).

The four examples briefly outlined above are indicative of the kind of cross-cutting searches for more ecological approaches to knowledge production and management. But what is there to connect these fragmented ecologies of knowing. On this point, we see a burgeoning of work on topics such as knowledge networking, dynamic knowledge interaction, and, closer to the subject at hand, planning support systems.

## **Knowledge Networking and Distributed Intelligence (KDI)**

KDI is a new funding program offered by the National Science Foundation. It is indicative of the dramatic growth in theories and practices associated with knowledge integration and management. The NSF’s KDI program “aims to achieve, across the scientific and engineering communities, the next generation of human capability to generate, model, and represent more complex and cross-disciplinary scientific data from new sources and at enormously varying scales; to transform this information into knowledge by combining and analyzing it in new ways; to deepen our understanding of learning and intelligence in natural and artificial systems; to explore the cognitive, ethical, educational, legal, and social implications of new types of learning, knowledge, and interactivity; and to collaborate in sharing knowledge and working together interactively.” The NSF’s knowledge networking emphasis supports multidisciplinary research on developing and employing the next generation of communication networks, associated information repositories, collaborative technologies, and knowledge management techniques to gather, create, distribute, use, and evaluate knowledge in new and secure ways. This explicitly includes research on the human, behavioral, social, and ethical dimensions of knowledge networking. <http://www.ehr.nsf.gov/kdi/>

To support knowledge integration across disciplinary boundaries there must be a common vocabulary and transparent ways to express and structure information. The emergence of XML (extensible Markup Language) has provided a means to structure such a vocabulary through the use of user-defined semantic tags, facilitating the exchange and even integration of data and information within networked communities of interest.

XML is a fairly recent (1998) markup standard, complementing and even replacing HTML. XML allows communities to form and define their own markup vocabularies. Chemistry, math, news, geography, banking, music markup and literally hundreds of other such “community” standardization efforts are under way. One such effort worth noting here is the IDML initiative (<http://www.idmlinitiative.org>). IDML stands for International Development Markup Language. It aims at becoming a data exchange standard for information that is specific to international development. Its goals are “to facilitate transparency, learning and coordination of action in the service of sustainable and equitable development”. Organizations participating in these discussions include: NGO-net, UN Center for Human Settlements (UNCHS), UNESCO, UNICEF and World Bank. One proposed implementation scenario, suggests that by using IDML as an exchange standard, agencies like CIDA, UNDP, IDRC and the World Bank, who typically use different proprietary databases systems for their project information, such as Oracle, Sybase, Lotus Notes, and MS SQL Server, could suddenly “share a large subset of information with each other over the Web.”

## Information Integration Based on XML Methodologies and Topic Maps

Information technology offers several approaches to data integration across multiple information sources. The wrapper/mediator approach [Wiederhold 1992], appears to be the most flexible as it allows for on-demand information integration between autonomously maintained data sources (an important requirement in a binational setting).

A recent effort, called the MIX system (Mediation of Information using XML) [Baru 1999], builds on the XML lingua-franca, showing how automated frameworks built on top of XML can be generalized. MIX is a wrapper/mediator framework being researched in the context of several federally-funded projects including the NSF Digital Government project called I2T (Information Integration Testbed).

*Wrappers* export a *common data model* view of the data at each source, along with information about the *schema* and metadata of the source and a description of the *supported queries*, which are expressed in a common query language. The common data model in MIX is XML, which is particularly well-suited to the semistructured nature of many of the sources that we will encounter. The queries are expressed in the *XML Matching And Structuring (XMAS)* language. Metadata are currently in the form of XML Document Type Definitions (DTDs) and XML Schemas. Clients/applications typically access sources through *mediators*, which combine, integrate, and refine data from wrappers providing applications with a “cleaner” *integrated view*, which in our case is presented as a virtual XML site.

MIX and other such systems, are dynamic or *on-demand* systems in the sense that neither the wrappers nor the mediators materialize (in some physical storage) the views that they export. Instead the views are *virtual*. During runtime when an on-demand mediator receives a query, it decomposes the query into multiple subqueries, which are also expressed in the common query language and are sent to the wrappers. When a wrapper receives a query, it translates the query into a source-specific query (or commands) that is issued to the source. On the return, the wrappers retrieve the source results and translate them into the common data model. The mediator then combines results returned by the wrappers into the final result. Such a virtual view is effectively always *up-to-date* because the query result presented to the client reflects the latest state of the sources. Achieving the same effect with a materialized view approach would require modification to the software at the sources in order to have them provide appropriate updates to the materialized view. XML-based interfaces are also increasingly becoming popular in displaying GIS data and integrating maps from different servers [Zaslavsky, 2000-b]. These interfaces are capable of reading vector geographic layer from XML files which in turn are produced by different data servers and by the spatial mediator, and render them directly in a browser using VML (Vector Markup Language) or SVG (Scalable Vector Graphics), XML grammars for 2D vector rendering.

One promising approach that makes use of XML is Topic Maps.<sup>11</sup> Topic Maps are a content navigation and metadata metaphor designed to help users more efficiently find information, both inside the organization (intranet/extranet) and on the Web. In the navigation paradigm of Topic Maps, users navigate through a conceptual space, which is a very different approach than now used in search engines like Google. At their

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<sup>11</sup> As defined by Paul Tooby in an article on this subject, “Topic Maps are a promising approach to taming the explosion of information that is affecting all of society from science and industry to education and beyond, providing a powerful navigational tool for organizing, retrieving, and accessing information resources. Through the creation of an independent “knowledge layer” above the information resources themselves, Topic Maps make it possible to organize and federate information independently of location, format, or operating system.” NPACI Online **Volume 5, Issue 13 - June 27, 2001** <http://www.npaci.edu/online/v5.13/mondeca.html>. Topic Maps are an international standard, defined by the ISO (ISO/IEC 13250:2000), and can also be interchanged using the Extensible Markup Language (XML) as defined by the World Wide Web Consortium (W3C), XML Topic Map standard, XTM. To learn more about Topic Maps see [www.topicmaps.org](http://www.topicmaps.org)

simplest level, Topic Maps can be seen as an electronic version of the index at the back of a book. Like an index, the Topic Map presents an array of subjects, along with links to the occurrences of information, which are like the page numbers in the book index. But Topic Maps provide further important capabilities, including specifying multiple kinds of relationships between topics. Topic Maps are the 'glue' that links all the topics in a given area, letting users find the information they want more transparently by navigating through the concepts of the subject area, rather than having to know the underlying way in which the information has been organized and stored.

The use of advanced information technologies in the planning field has seen a gradual shift into the so-called knowledge-based methodologies, or knowledge engineering ("The Practice of Local Government Planning, Third Edition, Chapter 3 – Planning in the information age, edited by Charles J. Hoch, University of Illinois"). The next section will attempt to provide a brief overview of information systems approaches and trends for integrated urban planning.

Recent literature categorizing promising information system directions for urban planning will typically cover areas such as Hypermaps, Knowledge-bases, Visualization, Groupware, Tools for Public Participation, Real-time Monitoring (see "Information Systems for Urban Planning: A hypermedia co-operative approach," by Robert Laurini, 2001). A summary of these 6 broad categories appears in Table 5:

**TABLE 1. ADVANCED INFORMATION TECHNOLOGIES IN PLANNING**

- Hypermaps

Hypermaps are also called clickable maps, or map-based hyperdocuments. This new area consists of tools for organizing spatial information and documentation over the Internet. Typically this might mean spatial referencing of documents, linking one map to another, linking historical documents and maps, multimedia, sound files, movies, etc. to spatial data.

- Knowledge-based systems

While information might be seen as implicit associations between data objects, knowledge is typically considered a higher level of abstraction, where associations and constraints on information objects and data objects are allowed. Knowledge can often be seen as a layer that can be decomposed into facts and rules. For example, knowledge could include rules about land-use categories, to try to automatically capture working assumptions. Robert Laurini contrasts earlier expert systems with knowledge-based systems. Expert systems make use of fact databases and inference engines where other facts can be deduced using encoded rules. In the author's view, the use of expert systems in urban planning has been problematic, as they do not necessarily interact with corporate databases and are usually closed in some manner. Knowledge-based systems on the other hand, allow the connection to outside databases and accept new applications.

Knowledge engineering "is the design and maintenance of knowledge-based systems" according to one expert. This means the management of various kinds of knowledge (implicit, explicit, spatial, structural, etc.). Other than facts and rules, constraints, decision rules, procedures, heuristics, etc. can also be stored and managed (e.g.: rules about rules – metarules, spatial metarules, etc.).

One significant technical development and trend, we will return to, is the development of ontologies. An ontology is a "specification of a conceptualization", typically the description of the concepts and relationships that exist within a domain. An ontology specifies a formal vocabulary, type relationships, constraints and thus, represents a powerful framework to specify and share knowledge within a community.

- Visualization

Visualization in urban planning has come to represent a variety of techniques from real-time display of sensor and simulation data, to symbolic display techniques, to immersive virtual reality environments, to complex navigation of information spaces (this includes hypertrees, and 3D displays).

- Groupware

With the advent of the Internet, techniques to allow multiple people to interact and work together from remote distributed locations are emerging. This includes group decision support systems, workflow modeling, GIS-based video-conferencing, etc.

- Tools for Public Participation

Urban planning environments of the future are bound to include more opportunities for citizens to participate and more openness in the process of decision making. Tools for public participation might make use of visualization and groupware, and may also rely on “opinion collection and information distribution”.

- Real-time Monitoring

With advances in sensor technologies, GPS, and mobile systems, new urban planning opportunities emerge. This largely corresponds to use of GIS, telecommunications and the Internet, which is why this field is sometimes referred to as “telegeomonitoring”. Transportation, chemical toxics, environmental monitoring are a few common areas of study.

(summarized from “Information Systems for Urban Planning: A hypermedia co-operative approach,” by Robert Laurini, 2001)

On a regional level, a recent survey (“Informed Regional Choices”, November 2000), conducted by the California Center for Regional Leadership describes the need for better planning and decision tools and presents a series of case studies in the following areas: Interactive web sites, Visualization tools, Spatial analysis tools (including GIS), Simulation, Groupware & collaboration tools, and Multimedia resource centers. Another important category that can be added to this taxonomy is Planning Support Systems (PSS). The World Planning Schools Congress (Shanghai, China July 2001) included a focus on PSS as part of a Track on Telematics and Application of Information Technology in Planning (<http://www.caup-tongji.org/wpsc2001/penglei/sessionlist5.htm>).

In an article titled, “Geographic Information Science Implications for Urban and Regional Planning”, Zorica Nedovic-Budic (URISA Journal, Vol. 12, No. 2, Spring 2000, pp.81-93), identifies PSS as a priority for research. PSSs support planning by integrating multiple technologies and providing common interfaces (think of them as workbenches or integrated planning toolkits). PSS subsumes collaborative planning systems, planning groupware, and co-operative work systems.

A preliminary survey of PSS in development either in academia (such as MIT, the University of Pittsburgh, the University of Texas at Austin) or with state planners (such as the New Jersey Office of State Planning) suggest that more research is needed in the following areas: Integrated web mapping, Online tools for community planning & public involvement, Multimedia representational aids, Hypermaps and visualization, Public comments management systems, and Regional growth simulation modeling and GIS. The growing need for integration tools in PSS and the needs for spatial interoperability have lead to interesting developments in common spatial exchange standards (see Open GIS consortium – <http://www.opengis.org>). Along these lines, the wrapper/mediator architectures discussed previously are strong candidates towards providing infrastructure for integrated regional planning, especially in transborder contexts. A novel approach in this field is the so-called ontology-based interoperability framework, where databases are wrapped or described using an ontology, and where shared ontologies are created when trying to query across databases.<sup>12</sup>

In what way might the kind of E-shifts, emergent ecologies of knowing, and advances in knowledge management noted above help articulate integrated regional planning in transborder city-regions? On this point, insight from one of regional planning’s most widely-cited scholars, John Friedmann, points a way forward. Friedmann’s work relates issues of globalization, territorial development, networking and sustainability. In a recent article titled, “Intercity Networks in a Globalizing Era,” Friedmann addresses six interrelated propositions:

- A limited number of city-regions are the major nodes and focal points of a globalizing economy;
- Finding an appropriate form of governance continues to be a critical concern for these regions;
- In today’s world, city-regions are increasingly responsible for managing their own development;
- The sustainable development of city-regions requires giving greater attention to the creation and conservation of regional wealth in its multiple forms;
- City-regions have much to gain (and nothing to lose) by associating with other regions in networks, especially, if not exclusively, across national borders, in the continuing quest for sustainable development;

<sup>12</sup> The following recent studies, offer some insights into this approach:

(a). “Multiperspective Development Environment for Configurable Distributed Applications” by Thanwadee Thanitsukkarn. <http://www-dse.doc.ic.ac.uk/~tt4/THESIS/thesis.pdf>

(b). “Ontology-based Geographic Data Set Integration” by Harry T. Uitermark et al. <http://link.springer.de/link/service/series/0558/papers/1678/16780060.pdf>

(c). “GIS Semantic Interoperability: an approach based on context mediation”, by Eric Leclercq, University de Bourgogne, France, Thesis, 2000.

- City-regions situated in geographical proximity to each other, but embedded in national economies of different levels of economic achievement and sharing cultural affinities, can collectively strengthen their competitive position by collaborating with each other in the creation of a sustainable common wealth.

In this paper, our primary focus is on the last of Friedmann's two propositions with special emphasis on the U.S.-Mexico Border region and the San Diego-Tijuana case.

## V. The U.S.-Mexico Border Region

International cooperation on trade and the environment has set the stage for new initiatives and collaborative efforts aimed at preventing pollution and promoting sustainable development along the U.S.-Mexico border (Pezzoli 2000a, 2000b). In an effort to facilitate binational cooperation and coordination, the 1983 La Paz Agreement defined the U.S.-Mexico border area as the region extending 100 kilometers on either side of the international boundary between the U.S. and Mexico. This region, a 2000-mile-long, 125-mile-wide strip extending from the Pacific Ocean to the Gulf of Mexico, was scarcely inhabited at the beginning of this century. The total population now exceeds 11.5 million, up from only 1 million in 1960. Much of the growth on the Mexican side has been intensified by the North American Free Trade Agreement (NAFTA) and fueled by the rapid expansion of over 1,800 maquiladoras (manufacturing and assembly plants that are owned by foreign parent companies). The combined population of San Diego and Tijuana has grown from 3.6 million in 1990 to more than 4.5 million in 2001, with the fastest growth occurring in Tijuana. The San Diego-Tijuana global city-region provides a gateway to the Pacific; as such it has become a nodal point in the expanding trade among Pacific Rim countries. The combined effects of urban and industrial growth on both sides of the border have generated a number of increasingly serious environmental problems. Chief among these are the over-exploitation and contamination of transborder ground and surface water resources; the lack of proper disposal or recycling of liquid, solid and hazardous waste; air pollution; and inadequate environmental infrastructure. It is widely understood that any solution to these problems requires binational collaboration [Liverman 1999], not just politically, but also in technical and scientific terms.

There is now a fast growing literature that examines the challenges of transnational collaboration and planning in the U.S.-Mexico border. Much of this work has focused on environmental issues in the wake of the North American Free Trade Agreement. But recently more emphasis is being placed on transborder metropolitan regionalism and planning. Herzog (2001) provides a good overview of transborder planning. From an historical perspective he outlines the many types of innovative public sector border alliances, federal NAFTA-driven liaisons, private cross-border coalitions, and local programs. Box 1 lists a number of recent initiatives specifically dedicated to transborder metropolitan regionalism.

**TABLE 2. CROSS-BORDER METROPOLITAN REGIONALISM: KEY EVENTS LED BY THE US-MEXICO BINATIONAL COMMISSION, 1999-2000**

### **Binational U.S.-Mexico Meetings. April and May 2000**

*III Binational U.S.-Mexico Meeting for the Exchange of Experiences of Metropolitan Nature; U.S.-Mexico Binational Committee Meeting on Planning and Administration of Metropolitan Regions*

Two successful working group sessions were held in April and May 2000 in Monterrey, Mexico and in San Francisco, California. Both the U.S. and Mexican delegations expressed an interest in working together to better understand regional planning issues based on their discussions on metropolitan planning intergovernmental coordination, metropolitan financing, and community participation.

### **Facilitation of Cross Border Urban Plans. May 2000-present**

Working to adapt and build on the successful experience of Laredo and Nuevo Laredo in creating a joint urban plan, HUD and SEDESOL have been actively working with these cities as well as Eagle Pass and Piedras Negras on this cross border planning project.

### **United States-Mexico Binational Meeting for the Exchange of Experience on Metropolitan Affairs. May 13-14, 1999**

This forum, held in Mexico City, Mexico, provided an exchange of knowledge and experiences in urban planning and development in urban areas. Various issues affecting metropolitan development were discussed, such as: patterns of human settlement, income distribution patterns, joint government management in metropolitan areas, fiscal inequality between metropolitan areas of government, and public and private sector participation.

**United States-Mexico Binational Committee Meeting on Planning and Administration of Metropolitan Regions, May 23-24, 1999**

Held in Washington, D.C. and Baltimore, MD, this forum served as a follow-up meeting to the above mentioned conference. A delegation of housing and urban development specialists from HUD and SEDESOL met in Washington, D.C. to explore the challenges of urban growth and establish the groundwork for cross-border cooperation in the planning and administration of metropolitan regions.

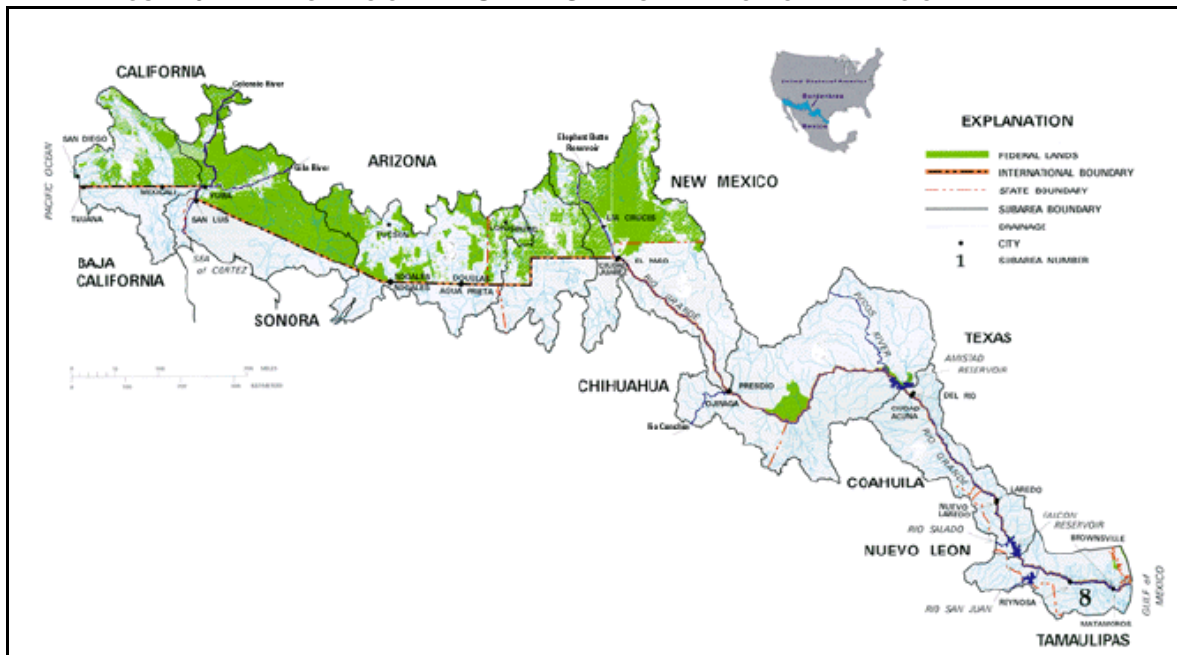
Source: *This partial list of activities was extracted from materials distributed by HUD, SEDESOL and San Diego Dialogue at a public symposium, titled, "Creating Partnerships on the Border: Housing and Urban Development in the Californias," September 27, 2000, San Diego, CA.*

While there are many factors that bode well for a deepening of cross-border collaboration, there are also many factors that simultaneously tear at this fabric. For instance, there are serious problems associated with the militarization of the border, the drug trade, and pressures of illegal migration and human smuggling. But here our focus is on positive elements. Specifically, to set the stage for our prescriptive discussion that follows, we briefly note two favorable dynamics: (1) the nascent institutionalization of a more integrated systems view of transborder environment-development interdependencies, and (2) Mexico's New Federalism and the growth of transborder planning capabilities at the local-regional level.

**THE NASCENT INSTITUTIONALIZATION OF A MORE INTEGRATED SYSTEMS VIEW OF TRANSBORDER ENVIRONMENT-DEVELOPMENT INTERDEPENDENCIES**

The theme of sustainable development has received much attention in the border region, in theory if not yet in practice. Public policy responses to environmental problems on the border include the creation of binational institutions such as the IBWC, BECC and CEC (Liverman et al. 2000). The latter two were established in response to environmental concerns raised by the North American Free Trade Agreement (NAFTA). Although the BECC officially endorses principles of sustainable development, efforts to operationalize sustainability criteria have been mired in conceptual and political problems. The Good Neighborhood Environmental Board (GNEB)—an advisory board created in the U.S. to counsel the president and congress on environmental issues and needs in the U.S. borderlands—has attempted to define new approaches to implement sustainable development. The GNEB seeks to institutionalize a border-wide watershed approach as the underlying standard operating procedure for all projects dealing with water resources management along the U.S. border with Mexico. The mapping of watershed resources is an important step in the right direction for integrated regional planning. However, as the GNEB points out, successfully harnessing a watershed approach along the border entails overcoming a potentially major hurdle: the 2,000-mile national political border that draws a sharp line through the region's watersheds and separates pieces of the same watershed into different jurisdictions (see Figure 5). The significance of Mexico's new Federalism comes into play here.

**FIGURE 6: WATERSHEDS OF THE UNITED STATES- MEXICO BORDER REGION**



Source: United States Department of the Interior, US-Mexico Border Field Coordinating Committee <http://www.cerc.usgs.gov/FCC/resources.htm#Regional>

## **THE NEW FEDERALISM AND GROWTH OF TRANSBORDER PLANNING CAPABILITIES AT THE LOCAL-REGIONAL LEVEL**

The Mexican political system has traditionally been defined by a strong central government headed by a powerful president. Over the last two decades, however, the combined effects of globalization, export-led industrialization, uneven development and internal political pressures (i.e., the decline of Mexico's long dominant one-party system) have spurred a shift in the balance of power toward state and municipal governments. Mexico's previous president, Ernesto Zedillo, referred to this as "New Federalism." The decentralization of political power in Mexico got major boost in 1989, when Ernesto Ruffo Appel, a member of the opposition party, National Action Party (Partido Accion Nacional, PAN), was elected governor of Baja California (Shirk 1999). Ruffo lobbied the federal government to transfer more of its public funding and responsibilities to states and municipalities. To a limited extent this has happened; the state has taken on more responsibility in the areas of education, health care, sewage and water, and rural transportation infrastructure. State governments, in turn, have passed onto municipal governments the primary responsibility for such areas as urban planning and building permits, traffic control, and parks and recreation facilities (Shirk 1999).

Mexico's current president, Vicente Fox, has continued to support, at least in principle, this devolution of powers. As David Shirk (1999) points out: "Mexico's northern border region was regarded in Mexico City's corridors of power as a political and economic hinterlands of little or no significance. In recent years, with the growing economic importance of the maquiladora industry and cross-border trade, and the ability of the Partido Acción Nacional (PAN) to establish a political toehold in the north, this perception has begun to change" (p. 1). At the regional level, governors of all the border states come together once per year "to further fortify partnerships by establishing recommendations for an economic, social and environmental vision" (Border Governors Conference, June 1, 2000, <http://www.bgc2000.com>). At the federal level, Mexico's new administration recently created a Commission for Northern Border Affairs (Comisión para Asuntos de la Frontera Norte, CAFN). The person heading this commission, ex-Baja California Governor Ernesto Ruffo Appel, has been dubbed the first "border czar." Shirk (2001) documents how the CAFN incorporates the chiefs and high-level functionaries from Mexico's secretariats of the Interior; International Relations; Treasury and Public Credit; Social Development; Environment and Natural Resources; Energy; Agriculture, Rural Development, Fisheries and Food; Communications and Transportation; and Tourism. The heads of the President's Office for Public Policy, the Office for Attention to Migrants, and the National Water Commission will also be integrated into the CAFN. Weighing the implications of this administrative move, Shirk (2001) argues that:

On the one hand, this structure reflects Fox's strategy of administrative organization, which involves the integration of different agencies with multiple policy jurisdictions under the umbrella of a coordinating commissioner. In this way, Fox hopes to promote interjurisdictional cooperation in addressing the border region's multiple problems. Ideally, by coordinating infrastructure planning with programs for environmental protection, for example, this approach could enable the commission to actually make some progress in promoting sustainable development in the region.

With respect to urban and regional planning, federal legislation in Mexico mandated the creation of quasi-independent local agencies to oversee long-term urban planning efforts. The creation of these agencies has the potential to improve cross-border planning. Indeed, one of these new planning organizations, called the Municipal Planning Institute of Tijuana (Instituto Municipal de Planeacion, IMPlan), has made comprehensive transborder planning one of its primary objectives

## **VI. The San Diego-Tijuana Transborder City-Region**

If conventional definitions of metropolitan areas were applied across the international boundary, San Diego and Tijuana would constitute a "consolidated metropolitan area" composed of two primary metropolitan areas. The San Diego Primary Metropolitan Area would be San Diego County. The Tijuana Primary Metropolitan Area would be the Tijuana, Playas de Rosariito and Tecate Municipios (Cox 2000). The combined population of this area is 4.5 million people, roughly 1 million of who live in Tijuana. It is the largest twin-city out of the fourteen that span the U.S.-Mexico border, and it has the busiest border crossing point (San Ysidro) in the world.

San Diego is one of the world's great milieus of innovation in telecommunications and the life sciences. Tijuana is the television production capital of the world. The San Diego metropolitan area's high quality of life, and Tijuana's relative prosperity compared to the rest of Mexico, have attracted heavy international migration, not only from Mexico and Latin America, but also from other countries throughout the world. Over 40 different languages

spoken in San Diego County schools (San Diego Dialog 2000). Migration into the region, coupled with large projected increases in local births over the next 15 years, has prompted concerns about urban sprawl in both San Diego and Baja California. In the San Diego metro area, political coalitions have formed to slow growth and to promote smart growth. Urban sprawl and inadequate infrastructure is also a problem in Tijuana. The metropolitan area of Tijuana is growing at a rate of more than 2.25 hectares per day. Every year, Tijuana's population is growing by 65,000 new city residents (a 5 percent annual increase).

Sanchez (1999) argues that planning in Tijuana has been totally inadequate. Urban growth has been unregulated and chaotic, with more than 50% of the city's housing stock developed in a manner that is either technically illegal or semi-legal (i.e., lacking requisite building permits, zoning, land tenure, infrastructure). Tijuana has a lot of land that is too steep for conventional human settlements, yet much of this steep terrain gets developed anyhow (it is often the only space low-income families can afford to acquire through processes of irregular settlement). Thus, there are many precarious hillside settlements that are prone to washouts, mudslides, and other natural disasters. Sanchez (1999) point how this situation has exacerbated the negative impacts of the regions periodic floods. Major floods that occurred in January 1993 and 1998 paralyzed the entire city. The same storm system caused almost no damage in San Diego, California. San Diego may be in better shape than Tijuana when it comes to floods, but both cities share the problems of urban sprawl.

In their book, *The Regional City: Planning for the End of Spawl*, Calthorpe and Fulton (2001) detail the litany of deficiencies that impact cities in the U.S., including San Diego:

Local governments make land-use decisions without the larger picture in mind, while state and federal transportation officials implement transportation policy in away that is not coordinated with its ultimate effect on land use. Individual housing decisions by local governments often create a regional imbalance that concentrates poverty and wealth in separate enclaves-with unfortunate results for both social and economic conditions. Important natural resources are squandered bit by bit, rather than enhanced and used as building blocks for a coherent regional open-space system. Even attempts to solve the problems created by this piecemeal approach tend to suffer from tunnel vision. Noble urban-revitalization efforts are undertaken in complete isolation from the region wide social geography that helped create the distressed neighborhoods in the first place. Important environmental-protection programs seek to preserve resources without attacking the root cause of why those resources are endangered in the first place. Air pollution is addressed with emission standards rather than strategies to reduce the acceleration of auto use. The list goes on.

Such problems have prompted California to seek stronger instruments for regional decision-making. A newly appointed State of California Commission is examining how the state might encourage the growth of more regional tools of governance. In San Diego County, the state legislature recently established the Regional Government Efficiency Commission (RGEC). RGEC is expected to develop a plan for consolidating and regionalizing transportation.

Common problems of urban sprawl, fragmented infrastructures and uneven development have prompted San Diego and Tijuana to expand capacity for cross-border information sharing and collaboration. Along these lines, two agencies stand at the front line of the challenges ahead; the San Diego Association of Governments (SANDAG) and the Municipal Institute of Tijuana (Instituto Municipal de Tijuana, IMPlan). SANDAG and IMPlan are both partners, with two research universities, in a prospective KINDRED (Knowledge-based Integration of Distributed Regional Environmental Data) project to be briefly described below. The KINDRED project is part of a Regional Workbench initiative dedicated to enabling integrated regional planning in the San Diego-Tijuana city-region.

### **SANDAG'S REGIONAL INFORMATION SYSTEM (RIS)**

As noted above, SANDAG is the metropolitan area of San Diego's regional decision-making forum and planning agency. Some of the most important services SANDAG provides, with input from a number of technical and policy committees, include forecasting and modeling concerning regional land use, binational, environmental, and growth management issues. SANDAG recently earned national recognition for its innovative approach to multiple species habitat conservation planning. The association seeks to extend this process across the border with Mexico. SANDAG also won the Outstanding Internet Web Site Award from the California Geographic Information Association (CGIA) at the California GIS Conference in March 2000. The award was presented for innovative use of web technology for GIS applications [**SanDAG 2000**]. SANDAG has developed a Regional Information System (RIS) that includes a strong cross-border dimension (see **Box 2**)

**TABLE 3: SANDAG'S REGIONAL INFORMATION SYSTEM (RIS)**

**San Diego Interactive Mapping page** <http://www.sangis.org/sangis/intmaps/>

This site offers free, online interactive access to geographic databases through a variety of web applications. SANDAG won the Outstanding Internet Web Site Award from the California Geographic Information Association (CGIA) at the California GIS Conference in March 2000. The award was presented for innovative use of web technology for GIS applications. SANDAG was recognized for this award for both the dissemination of geographic and non-geographic information from their general web site as well as for their interactive mapping applications. The interactive mapping site is made possible by SanGIS, a Joint Powers Agreement (JPA) between the City and County of San Diego. The SanGIS Mission is to maintain and promote the use of a regional geographic data warehouse for the San Diego area and to facilitate the development of shared geographic data and automated systems which use that data.

**Regional Economic Development Information (REDI) System** <http://cart.sandag.cog.ca.us/redi/>

REDI pulls together a number of important geographic databases from both SANDAG and SanGIS, packaging them into an intuitive system that can be operated by anyone with an Internet connection.

**Mapping SANDAG's Demographic and Economic Databases**

<http://cart.sandag.cog.ca.us/demog/default.htm>

DEMS can be used to map data from SANDAG's Regional Information System, an extensive database covering numerous geographic levels and topics in the San Diego Region. DEMS contains data from the 2020 Regional Forecasts and Estimates of Population and Housing (1998) databases. There are two new geographic levels: U.S. Postal Zip Code Areas, and Community Plan Areas for the City and County of San Diego.

**San Diego Industrial Economic Clusters** <http://cart.sandag.cog.ca.us/cluster/>

This Industrial Cluster Interactive Mapping tool is designed to aid planners and decision makers, as well as the general public, in identifying where firms that comprise Industrial Clusters are located within the county of San Diego. Not only can you map any number of clusters, you can also identify them to display information such as firm name and address, SIC code, and number of employees. The interactive mapping tool allows you to zoom in and out, and pan around the image.

**San Diego / Tijuana Demographic Atlas** <http://cart.sandag.cog.ca.us/sdtij/intro.html>

The San Diego/Tijuana Atlas provides demographic and housing statistics from both sides of the border. The Demographic Atlas was compiled by San Diego Dialogue at the University of California, San Diego, with support from the San Diego/Tijuana Planning for Prosperity Fund.

**Borderbase** <http://www.borderbase.org/>

BorderBase is a bilingual directory of governmental organizations, agencies, and non-profit institutions that conduct work along the California-Baja California border. The BorderBase project seeks to promote cross border collaboration and understanding by providing a simple networking and information tool for local border communities. The BorderBase directory provides contact information, project descriptions and links to government agencies, non-profit organizations, academic institutions, and other groups that are involved in activities related to the California-Baja California border region.

NOTE: The RIS is described in detail in a PDF file titled *Regional Information System Overview*. The report can be downloaded from SANDAG's website at

[http://www.sandag.cog.ca.us/whats\\_new/publications/general/regional\\_info\\_system\\_2000.pdf](http://www.sandag.cog.ca.us/whats_new/publications/general/regional_info_system_2000.pdf). The descriptions in this box were copied from SANDAG's website at <http://www.sandag.cog.ca.us/index2.html>.

SANDAG promotes coordination of regional planning with the local, state, and federal governments of Mexico through a number of activities, including meetings with Mexican elected officials and staff, joint mapping projects, co-sponsorship of joint environmental conferences, studies of transportation and economic development, and coordination with other United States and Mexican organizations with similar interests. SANDAG has organized the Committee on Binational Regional Opportunities (COBRO). Its purpose is to advise and make recommendations to SANDAG concerning both short and long term border-related issues. It also identifies ways to assist and coordinate with other agencies and organizations working in the binational area. SANDAG is a

member of the Bi-State Transportation Technical Advisory Committee (BTTAC). This is an organization of six Baja California and six southern California governments, working together to coordinate transportation planning in the entire region of the California-Baja California international border. SANDAG participates in the Ports of Entry Council and the Regional Water Council, organized under the Border Liaison Mechanism (BLM). The BLM is a process organized by the Consuls General in San Diego and Tijuana to resolve local cross border problems through its Councils.

Our focus here is on SANDAG's prospective collaboration with IMPlan through the KINDRED project.

### **The Municipal Planning Institute of Tijuana (IMPlan)**

IMPLAN currently has about 70 full time employees. It is the only agency in the Tijuana metropolitan area that is responsible for urban and regional planning. Most of the agencies budget goes to salary. It has very little available for actual projects. Despite its meager resources, IMPlan is an impressive agency. It is at the cutting edge of applying information technology to land use and regional planning. The agency recently won a Grand Showcase Award from ESRI (Environmental Systems Research Institute) the world's largest producer of GIS software.

IMPlan has made transborder planning a high priority (see **Box 3**)

**TABLE 4. IMPLAN'S TRANSBORDER PLANNING MISSION STATEMENT**

IMPlan, as the planning organization for Tijuana, is confronted with a special planning task, i.e., to engage in COMPREHENSIVE TRANSBORDER PLANNING. For this reason an advisory consulting group was formed with specialists from the public and private sectors as well as academia from both sides of the border to develop policies and plans related to this issue.

Comprehensive transborder planning is necessary to respond to the unique socioeconomic, ecological, political and physical characteristics of the transborder system and to develop short, medium and long term development strategies for the transborder region.

Comprehensive transborder planning offers the opportunity for a long range vision for the future of the transborder community. Comprehensive transborder planning takes into account all the interrelationships of the planning components of the transborder system and reflects the goals of a wide variety of government organizations, individuals and community groups.

#### **GOALS**

- Promote comprehensive transborder planning with organizations from the public and private sectors on both sides of the border.
- Promote the institutionalization of transborder planning, by creating organizations, procedures, laws and other tools (including financing mechanisms), and by fostering a "transborder planning" culture in society.
- Support organizations with studies, plans and projects related to transborder planning. Develop joint projects.
- Generate funding for studies, plans and projects.

*Source:* Instituto Municipal de Planeacion, IMPlan, June 2001.

One of IMPlan's primary concerns is the integration of land use planning, transportation and infrastructure development. IMPlan's mission statement outlines the agency's objective along these lines. That is, "To develop transborder land use, transportation and infrastructure studies that consider the impact of growth from one side of the border to the other. These studies would integrate separate existing land use plans and lead to the development of a transborder comprehensive plan that would be the basis for a multi-year capital improvement program that would avoid the possible duplication of infrastructure and services (airports, roads, etc.)" (IMPlan 2001). In light of this objective, IMPlan joined forces with SANDAG; the University of California, San Diego; and the Colegio de la Frontera Norte (COLEF) to promote the KINDRED project (currently under review for funding by the National Science Foundation for one of the NSF's Information Technology Research grants. Partial support

for the KINDRED project's development is already in place from UC San Diego's Superfund Basic Research Program's Outreach Core (<http://superfund.sdsc.edu>)

## The KINDRED Project and the Regional Workbench

KINDRED is an acronym for knowledge-based integration and navigation of distributed regional environmental data). The KINDRED project will create and explore a new framework for integrated decision-making in transborder metropolitan planning (Pezzoli, Marciano, and Zaslavsky 2001, <http://kindred.sdsc.edu>). This framework is standards-based and uses XML and Topic Maps for organizing integrated semantic views that bridge cultural, economic, and social contexts. XML is the emerging Web standard ("intelligent" mark-up language) for data exchange on the web. Topic Maps are a standard for describing knowledge structures and associating them with underlying information resources. Sometimes described as semantically customized views of data, Topic Maps are intended to provide a solution for organizing and navigating large information pools (NPACI On-Line article, June 2001).

Topic Maps can be viewed as a standards-based bridge between knowledge representation and information management (ISO/IEC 13250, January 2000). More recently, an initiative called XTM (XML Topic Maps) [XTM 2000] has emerged, to implement the Topic Map standard in a Web context. Topic Maps are thus emerging as a strong candidate for expressing organizational and contextual knowledge.

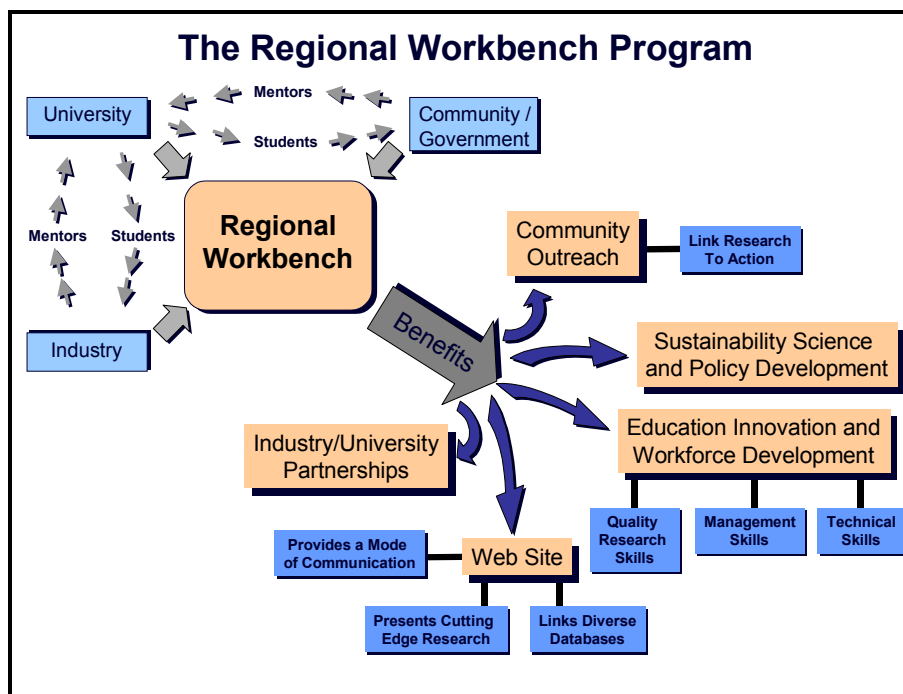
The main objectives of the KINDRED project are: (1) developing a new framework to handle the growing needs for harmonization and integration of information across the border, (2) developing and prototyping an integrated land use system which will serve as key input for binational decision-making and conflict resolution. The aim is to address the following innovative issues:

- Development of formal knowledge maps for selected types of land use, using the Topic Maps ISO standard, now being standardized as an XML-based version, called XTM
- Exploring mechanisms for enhancing these topic maps with local semantics of land use categories, knowledge about spatial relationships between them, and auxiliary information
- Creating a set of query templates and exploring dynamic interfaces for navigating, merging and querying spatially-enhanced topic maps for land use on both sides of the border.

The methodologies developed will go beyond the motivating example of integrated land use, as they can apply to other types of conflict resolution and harmonization. This effort is part of a larger Regional Workbench (RWB) initiative. The RWB program is a nascent web-based network joining university, industry and non-profit partners in the San Diego-Tijuana global city-region. TELESIS, a non-profit research and human service organization that specializes in strategic planning for community collaboratives, is core partner of the RWB. On May 25, 1999, the UCSD's Urban Studies and Planning (USP) program and UCSD's Vice Chancellor of Research signed an MOU with TELESIS. TELESIS is heading up an innovative "Quality of Life" Indicators and Data Warehouse project for the San Diego-Tijuana global city-region <see <http://qolsandiego.net>>.

The RWB is dedicated to integrating knowledge and action for sustainable urban-regional development <<http://regionalworkbench.org>>. The RWB initiative, which spawned the KINDRED project, has three broad long-term objectives: (1) enable excellence in graduate and undergraduate research education and training, including workforce development, (2) facilitate the creation, integration and sharing of data and multidisciplinary knowledge across academic divisions, including the social and natural sciences, humanities, engineering and health, and (3) establish an innovative means for linking research to policy and action in urban and regional development (see Figure X). One of the RWB's ongoing initiatives is a collaborative project focusing on a low-income human settlement called *Colonia 10 de Mayo* located near the U.S.-Mexico border. Most of the workers living in this settlement are employed in nearby maquiladoras. Through a collaborative planning process involving a coalition of university, government, industry, and community stakeholders, the 10 de Mayo project aims to create a redevelopment and investment strategy that will mobilize resources from within the community and attract funding from the nearby maquiladoras. The working hypothesis is that the San Diego-Tijuana region's comparative advantage and regional competitiveness will suffer unless Transnational Corporations begin to invest more in local community development and urban infrastructure.

FIGURE 7. REGIONAL WORKBENCH PROGRAM



Another ongoing project of the Regional Workbench is supported by the Outreach Core of the UC San Diego Superfund Basic Research Program (SBRP). The SBRP's Outreach Core connects research on Superfund toxics to the needs of community-based partners in education and industry. The industry partnership integrates scientific knowledge about basic biological, chemical, and physical aspects of Superfund toxicants with efforts to improve corporate environmental management systems, government regulations, and community-based decision-making processes. As a part of this initiative, the Superfund program has teamed up with UC San Diego's Urban Studies and Planning Program and the San Diego Supercomputer Center to organize available spatial datasets into a federated transborder set of GIS sources. This effort, in synergy with the KINDRED project, takes advantage of the federated spatial database technology advanced by the San Diego Supercomputer Center. Since different geographic databases reside on different platforms, in different software environments and formats, at different geographic locations, and may have employed varying data definition and collection standards, GIS interoperability becomes the central issue in development such a federated environment. A technology being developed at the San Diego Supercomputer Center addresses this problem by XML-wrapping of existing geographic sources, and processing spatial queries to a Federated Database with an XMAS-based spatial mediator (<http://www.npaci.edu/DICE/MIX>). XML is the emerging Web standard for data exchange. The spatial mediation of federated sources has the following advantages as a unique approach:

- It has an extensible architecture, allowing the users to register and incorporate new geographic sources as they become available;
- It will bring together diverse US and Mexican entities responsible for the shared border environment;
- It supports decentralization of environmental and health management through local information capacity building and improved communication between participating agencies;
- By providing a uniform Web-based access to the shared spatial data, it will empower community groups, non-governmental organizations and industrial entities without the need for expensive GIS software and expertise.

The National Research Council (1999: chap. 6) would characterize the RWB and its KINDRED project as a "knowledge-action collaborative," that is, an alliance of diverse and sector-specific groups jointly mobilized to design strategies and institutions that enable adaptive management and social learning for sustainable development. A number of such collaborative research and action networks are coming together in the United States (Nyden, et al. 1997, Schon, et al. 1999) and around the world (Ravetz 2000).

The RWB's KINDRED team has identified the following specific regional target areas and issues that could directly benefit from innovative integration strategies and information systems methodologies. The target list is by no means exhaustive.

- **Land Use**

- Integrating land use scenarios on both sides of the border and developing multi-stakeholder consensus-building strategies to plan urban land use and resolve site-specific disputes [CBI 2000].

- Development of transborder watershed research programs such the one outlined by the Good Neighbor Environment Board and the Federal Geographic Data Committee (FGDC) in conjunction with the National Spatial Data Infrastructure (NSDI) program [TJWater 2000].

- **Environmental Planning**

- Preservation & protection of water recharge areas

- Beach rehabilitation

- Multiple Species Conservation Program. Interestingly, while the County of San Diego has launched the largest MSCP program in an urban area across the country, the ecological preservation corridors defined stop right at the border [MSCP-San 2000] [MSCP-County of San 2000].

- **Transportation**

- Travel demand models for the region (San Diego-Tijuana) as a whole, under increasing daily border crossing activity. Existing transportation models require land use categorizations as one the input sources.

- **Environmental Health**

- Linking population, environmental and health data across the border, including toxic release data for San Diego and Tijuana. Registries tracking statewide tumors, childhood birth defects will allow relationships to be drawn with environmental contaminants and socio-demographics. See [Borderhealth 2000] for already started efforts in optimizing health and quality of life along the U.S./Mexico border.

As cross-border interactions and environmental influences intensify, so does the importance of coordinated approaches to land use planning and zoning. The following table gives a summary of key cross-border variables, showing how they differ and suggesting a need for harmonization:

**TABLE 5. A SUMMARY OF KEY CROSS-BORDER VARIABLES, SHOWING HOW THEY DIFFER AND SUGGESTING A NEED FOR HARMONIZATION**

Variables	U.S.	Mexico
Mapping Coordinates	State Plane Coordinates for CA	UTM Coordinates (Universal)
Census Jurisdictions	Census Tracts	AGEB (Basic geo-statistical area)
Political Jurisdictions	Boundaries (water, schools, districts, etc.)	Based on other standards
Environment	Vegetation & Habitat Classification	Based on different classifications
Risks	Landslides (Criteria to determine landslides)	Different criteria
Environmental Standards	Impact Buffer for Creeks and Faults	Alternate definitions
Land Use	e.g: Low Density Residential Estates	e.g.: Mexican counterpart = Low Density Residential Poor Farms
Transportation	Trip Generation (Higher)	Trip Generation (Lower)
Topography	Slopes Criteria for Classification	Different slope values
Geology	Geology Criteria for Classification	Different classification

Source: Carlos Graizbord, Director, IMPlan; Michael McLaughlin, San Diego Association of Governments

From a comparative perspective, one can identify a number of approaches to harmonizing cross-border representations of land use and other environmental and social indicators. In addition to efforts in the US-Mexico border region, there have been European integration projects, and the African land cover projects. From methodological and data handling perspectives, we can distinguish between approaches focused on semantic reconciliation of available land use inventories, and those focused on creating and interpreting a uniform land cover data set for the border area, typically using remote sensing data. Between the two extremes, there are several examples of a joint use of remote sensing and local legacy land use data.

### Previous Land Use Integration Approaches and the KINDRED Approach

Previous approaches to harmonizing cross-border representations of land use and other environmental and social indicators have been developed in the context US-Mexico border studies projects, European integration projects, and the African land cover projects, in particular. From methodological and data handling perspectives, we can distinguish between approaches focused on semantic reconciliation of available land use inventories, and those focused on creating and interpreting a uniform land cover data set for the border area, typically using remote sensing data. Between the two extremes, there are several examples of a joint use of remote sensing and local legacy land use data.

#### SEMANTIC RECONCILIATION:

A representative approach integrates neighboring land use maps by developing a common nomenclature to which both land use classification systems can be accurately reduced. Such an example is the San Diego – Tijuana International Border Area Planning Atlas [Ganster 2000] (Figure 2). The 90-category land use system used for the U.S. side of the border, and the 24-category system used in Mexico, were converted to 9 target categories. Creating a homogenized snapshot of cross-border land use and several other demographic and environmental indicators is very useful for border-area planning. The problems of this methodological approach are related to loss of information, the static nature of the presentation and the difficulty to update the maps.

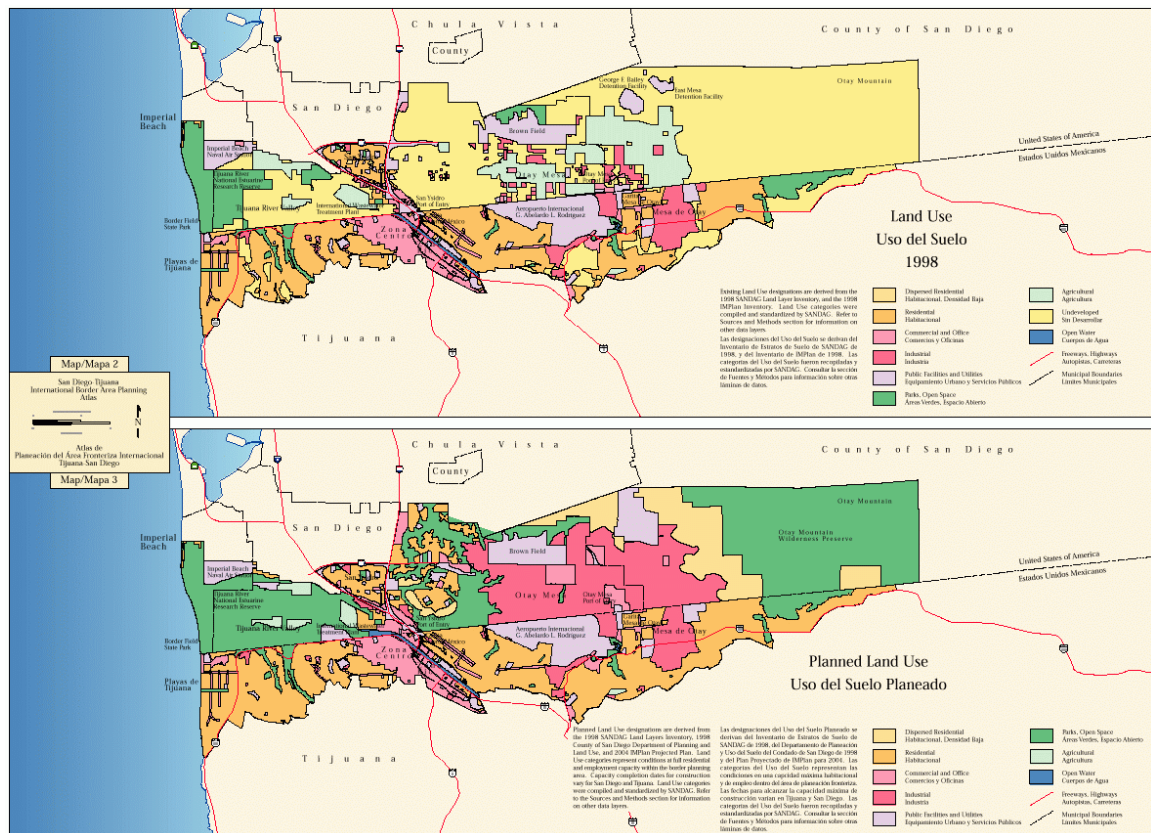


Figure 8: Cross-border Land Use Map: San Diego/Tijuana International Border Area Planning Atlas (source Ganster 2000)

## REMOTE SENSING UTILIZATION

Another group of approaches uses uniformly collected remote sensing data (such as Landsat TM or SPOT satellite imagery) to arrive at a uniform land use/land cover classification over transborder areas. Of particular interest is a progression of European land use/land cover integrative databases developed over the last 15 years.

The “10-minutes” pan-European land use database (ELU-1) of the Dutch National Institute for Public Health and the Environment [Van de Velde 1994] distinguished 8 land use classes, presenting areal distributions of land use for each 10-minute cell (i.e. about 10x15km). As mentioned in [Mücher 2000], drawbacks of the database, apart from low spatial accuracy, resulted from the difficulties of integrating statistical and spatial data derived from many sources which differed in spatial accuracy, reliability, acquisition date and class definitions.

The European CORINE (Co-ordination of Information on the Environment) land cover database (originated in 1985) is derived from satellite data in combination with ancillary information. The final product describes vegetation and land use by 44 classes, grouped in a three-level nomenclature [CEC 1993]. However, no update procedure is currently in place, and the database suffers from different timing of imagery acquisition and interpretation. The final product (which is supposed to include the European part of Russia as well), when and if completed, does not include any update procedure.

The PELCOM (Pan-European Land Use and Land Cover Monitoring) database establishes a 1 km land cover database derived from 1-km resolution NOAA-AVHRR satellite data [Van Katwijk 2000]. The three-year project started in 1996, and attempts to maintain an accurate (and updatable – compared to CORINE) transborder database by 16 land cover classes.

## HYBRID APPROACH

A project integrating imagery data with local land use classifications is being conducted in Africa by the Food and Agriculture Organization (FAO) of the U.N. The Eastern Africa module of the Africover project [Alinovi 2000] attempts to reconcile land cover/land use legends of 10 neighboring countries. In this case, the land use classifications adopted in the countries were mapped into FAO-developed Land Cover Classification System (LCSS). By contrast to the San Diego-Tijuana Atlas example, the target classification system represented a homogenized hierarchical “superset” to which all other classifications could be mapped, rather than a generalization of input classification systems. This uniform classification, like in the recent European projects, is made possible by the use of a common data source, the Landsat TM 30m satellite imagery.

The focus of PELCOM, Africover, and other databases derived from satellite imagery, is primarily a uniform description of land cover than land use. Land cover refers to physical coverage of the land while land use refers to its functional use which is subject to socio-economic and technological circumstances, demographic factors, infrastructure, land tenure system, etc. As mentioned in [Turner 1995], land use lacks a common terminology and unit of analysis, and doesn't lend itself well to a universal classification scheme, “due to many dimensions and driving forces behind regional land use, and multiple possible applications of land use data.” Sometimes it is possible to infer land use from land cover obtained from satellite imagery, but a detailed and accurate interpretation requires local knowledge and integration of a variety of ancillary sources. The Land Use Integrator project, a part of European PELCOM database effort, represents such as attempt to automatically integrate multiple ancillary sources into the satellite imagery interpretation process [Van Katwijk 2000]. While the project is at an early stage, and its results are not known yet, the methodology for integrating diverse information sources deserves consideration. A step-wise procedure first identifies pixels about which different sources are in agreement about how the pixels should be classified. On the next step, each remaining pixel receives a probability estimate of belonging to a particular target class, based on source characteristics and source reliability. Calibration with available regional statistical sources completes the process of developing an integrated land use map.

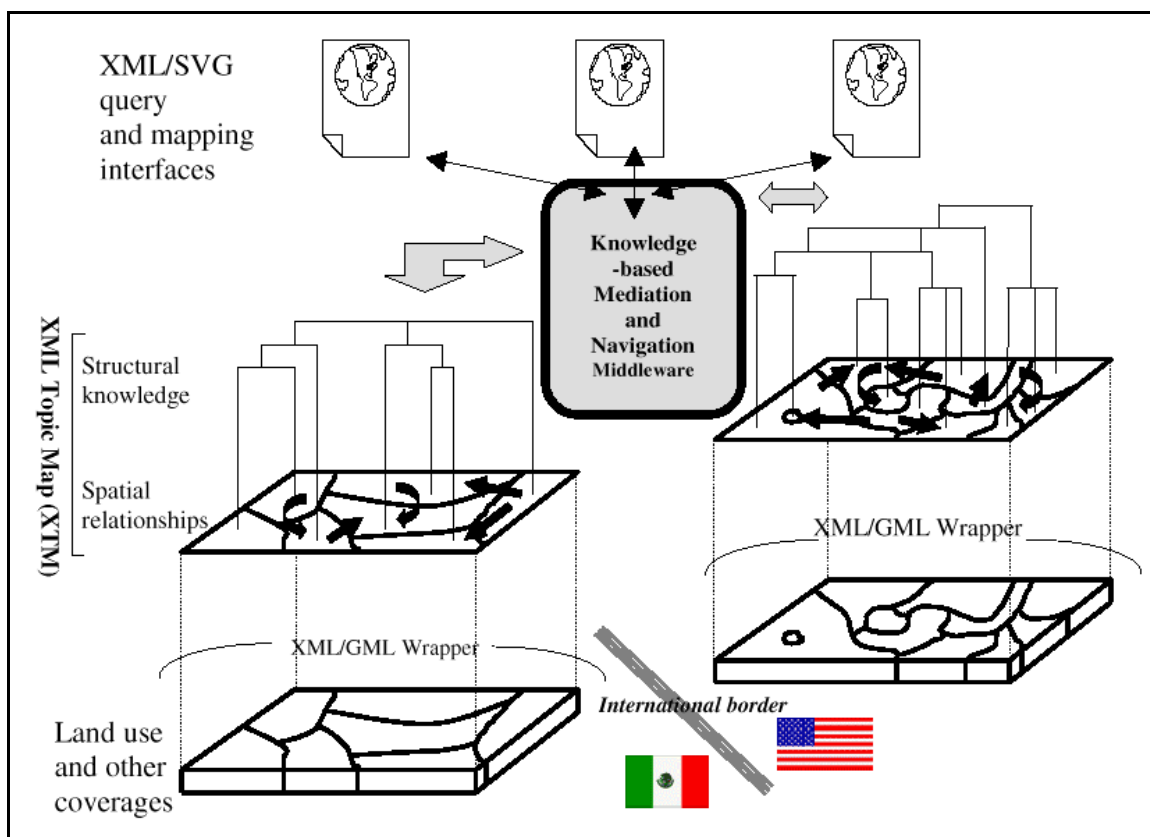
## THE KINDRED APPROACH

For the KINDRED project, our plan is to develop a Spatially Integrated Regional Information Testbed (SPIRIT). A conceptual view of the proposed KINDRED SPIRIT testbed is shown in **Figure 3**. While following the general three-tier composition of wrapper-mediator systems, our testbed will include, for each data source, an additional “knowledge wrapper” layer. This layer will supplement the standard Open GIS recommended wrapping of spatial data using the Geography Markup Language (GML). It will contain XML-encoded elements of structural (embedded in land use hierarchy) and spatial knowledge. The communication between different tiers of the system will use XML-based protocols. The XTM XML land use Topic Maps relate on one side to the underlying XML-wrapped land use information sources, and will participate on the other side with the Knowledge-Based Middleware module. The main research issues that need to be addressed in this architecture are: the internal structure of the XTM wrapper, the interface between XTM and the underlying XML/GML source wrappers, the

interface between XTM and the mediation middleware, the construction of this mediation middleware, and finally the design of the query interfaces.

SANDAG and IMPlan have both agreed to collaborate in the exploration of using the Knowledge Map methodology and XML-based information mediation systems. Advancements in Information Technology are critical to both SANDAG and IMPlan. Both agencies maintain an extensive Geographic Information System inventory of various types of land use and transportation information which is utilized to aide local decision-making and to provide information on a broad range of topics pertinent to the region's quality of life. Since SANDAG represents all the local jurisdictions of the San Diego region, they have the need to integrate multiple data sources across various agencies. SANDAG actively pursue cross-border planning with IMPlan in Tijuana and in other areas of Baja California. But these collaborative efforts regularly encounter many difficulties in data integration across the border. SANDAG and IMPlan could benefit greatly from an automated method that would allow the integration of similar geographic data that has different classification systems into a single portrayal of the entire binational region.

**FIGURE 9: A KNOWLEDGE-BASED TOPIC MAP SYSTEM FOR THE INTEGRATION OF TRANSBORDER LAND USE AND OTHER DATA**



## VII. CONCLUSION

This paper presented a series of interlinked arguments, summarized here in three main points: (1) To improve quality of life and place in today's fast-growing city-regions requires an integrated regional approach informed by principles of sustainable development; **yet** (2) Globalization, neoliberalism and low-density urban sprawl have combined in ways that make integrated regional planning difficult to achieve. Fragmented ecologies of knowing, disarticulated infrastructures and uneven development thwart integration; **thus** (3) There is a pressing need to build capacity for social and institutional learning, regulatory innovation and eco-efficiency in systems of production, distribution, and consumption. Along these lines, collaborative efforts to build interactive regional information systems, and "Regional Workbenches" are promising. The RWB approach can facilitate transborder Integrated regional planning and development by mobilizing an ecology of agents whose modus operandi includes peer-reviewed science, state-society synergy, civic engagement and efforts to advance principles of

social democracy. Principles of distributed intelligence, federation, and dynamic knowledge networking are key. In this conclusion, we reflect on each of these points in the context of efforts to enable/promote integrated regional planning in transborder settings.

## 1. INTEGRATED REGIONALISM AND THE SUSTAINABILITY CHALLENGE

This paper opened with the argument that resource-intensive industrialism and rapid urban-demographic growth have become large-scale biogeophysical forces on earth. Unfortunately, developing the socio-technical capacity to gauge the implications (sustainability) of these growth trajectories has not been a high priority. In the San Diego-Tijuana cross border regions there does not even exist a simple integrated base map showing the regions topography and coastal zone bathymetry (although the RWB collaborative is in the process of building such a base map).

In an article titled "Information Technology for Public Policy," Roberta Balstad Miller (1996: 8) notes that understanding how human action affects environmental change is dependent upon the creation of merged, georeferenced, time-series databases. Such databases should contain both socioeconomic and physical data that reflect the interaction of human and physical forces over time. The data sets available for such a task are piling up—in government databases, digital libraries, data warehouses, company files, and research labs. However, as Miller and others point out, before policy analysts will be able to take full advantage of new information-rich technologies in environmental policy and assessment, a number of scientific and technical problems must be addressed. These include (1) the need to create merged data sets (i.e., data sets which encompass both socioeconomic and physical/biological data), (2) the need to develop both time-series databases and baseline data; and (3) the need to expand access and electronic capability in developing countries (Balstad Miller 1996: 8).

As we have noted in this paper, it is difficult for government agencies and firms in the border region to collect accurate and comparable information about their environmental impacts (US EPA, April 1998). The time and expense needed to collect and report such data can be prohibitive. Also, it is not always clear what should be the appropriate geographic focus—local, regional, or global. From the perspective of promoting "sustainable development," the challenge becomes even more daunting. Among other things, sustainability necessarily calls into view what ecological economists have termed "shadow ecologies." Unlike other issues such as equity and economic efficiency, the import of the shadow ecology concept for integrated regionalism is only dimly appreciated. Part of this problem stems from the way in which data has been collected (the legacy issue).

The World Bank is one of most significant assemblers of comparative data on the world stage; including environmental performance data. However, World Bank data largely focuses on the nation-state as its unit of analysis, beginning with so-called national accounts. As John Friedmann (2001) points, "This pattern has been with us for so long—more than half a century—that we assume it to be the only reasonable way to conceive of territorial economies." In the field of regional planning and analysis, alternative constructs were developed during the post-WWII period to capture regions as the basic unit for analysis (Perloff and Leven 1964), but these methods did not take root. More recently, however, there is rising interest in the so-called "new regionalism." Consequently, more attention is being focused on understanding the growth of city-regions as a process within a global system (Friedmann and Wolff 1982; Friedmann 1986, 1995, 1998b; Sassen 1991, 1994; Knox and Taylor 1995).

As we've argued in this paper, the new regionalism is a good framework within which to incorporate principles of sustainability. But the legacy problem associated with national data sets will have to be resolved. National data sets are flawed because they do not reflect the fact that nearly all nations use "shadow" natural capital: resources and environmental services from outside their borders gained through international trade. Societies that have made the most progress toward "solving" (at least the most evident) pollution problems are the most affluent—and typically the most resource-intensive—ones which, on balance, are exacting a far greater toll on the environment than are countries such as Mexico, Colombia or Thailand. A recent study of Germany, Japan, the Netherlands, and the US documents the immense volume of natural resources required to run a developed economy—in the range of 45 to 85 metric tons of material per person each year.<sup>13</sup> Much of this material flow—including mine tailings, eroded soil, logging debris, and excavated earth and rock—does not end up in final products. The staggering tonnage of such flows accounts for as much as 75 percent of the total materials used in

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<sup>13</sup> A. Adriaanse et al., *Resource Flows: The Material Basis of Industrial Economies*, a joint publication of the World Resources Institute (WRI); the Wuppertal Institute; the Netherlands Ministry of Housing, Spatial Planning and the Environment; and the National Institute for Environmental Studies (WRI, Washington, D.C., 1997), p. iv.

industrial economies.<sup>14</sup> These flows do not enter the economy as commodities so they are not accounted for in national gross domestic product. This omission is problematic in so far as it impedes accounting for the massive scale of environmental alteration and externalities associated with such flows. And given the globalization of the economy, the resulting impacts of these flows (e.g., watershed pollution, habitat degradation) often register in poorer countries outside the developed economies that benefit most from the process.

As Vellinga, et al. (1999) point out, the consumption of shadow natural capital from foreign and global stocks enables a population to live beyond the means sustainable by domestic sources. Wackernagel and Rees (1996) have developed the concept of *ecological footprint* as an indicator that attempts to account for the international linkages in the use of environmental services (stocks of natural capital). The ecological footprint of a certain population (e.g., the people residing in a particular city-region) is the aggregate land area required to grow food, assimilate wastes, etc. relative to said population's domestic capacity to supply those resources and services. There are numerous regional examples of the shadow natural capital used by populations. For example, the 30 largest cities in the Baltic Sea drainage basin use 200 km<sup>2</sup> of terrestrial and aquatic ecosystem for every 1 km<sup>2</sup> of urban area to produce their use of agricultural, forestry, and fishery products (Folke et al., 1996). The Netherlands' shadow use of natural capital is at least 15 times its own size (Wackernagel, 1996).

These observations underscore the significance of working at a regional level, but in a way that is conscious of, and networked with, progressive efforts in other regions. This is the point we made in citing the work of Friedmann (2001), "City-regions situated in geographical proximity to each other, but embedded in national economies of different levels of economic achievement and sharing cultural affinities, can collectively strengthen their competitive position by collaborating with each other in the creation of a sustainable common wealth" (p. 120). This challenge resonates with what the National Research Council's Board on Sustainable Development has identified as three high priority tasks for advancing the research agenda of what they call *sustainability science*: "Develop a research framework for the science of sustainable development that integrates global and local perspectives to shape a place-based understanding of the interactions between environment and society; Initiate focused research programs on a small set of understudied questions that are central to a deeper understanding of those interactions; [and] Promote better utilization of existing tools and processes for linking knowledge to action in pursuit of a sustainability transition" (NRC 1999: 279).

## 2. ON WEAVING TOGETHER FRAGMENTED ECOLOGIES OF KNOWING

Emergent theories and practices associated with the new regionalism and sustainable development present a compelling rationale for thinking and acting at the scale of city-regions. Yet, as we've pointed out in this paper, globalization, neoliberalism and low-density urban sprawl have combined in ways that make integrated regional planning difficult to achieve. Fragmented ecologies of knowing, disarticulated infrastructures and uneven development thwart integration. This is a complicated scenario, part of which is epistemological.

When first generation environmental policy was initially drafted several decades ago many of the new types of environmental problems we face today were not yet in view. Now there are serious gaps in what environmental regulations cover. In the U.S. and Mexico, for instance, current environmental laws focus almost entirely on manufacturing facilities, especially the larger industries that have historically been the most heavily polluting (e.g., refineries, chemical and power plants, automobile industry). But new types of environmental problems have emerged. In Southern California and Baja California, for instance, non-point source pollution (including, for example, nutrients, bacteria, sediment, pesticides, and chemicals) runs off millions of backyards, farms and streets into storm drains. This constitutes one of the biggest environmental threats to the regions coastline. Diffuse sources of pollution also include such things as emissions from gas stations and millions of motor vehicles. In addition to non-point source pollution, there is growing concern about a host of other problems that eluded traditional environmental policy approaches. Notable examples include the atmospheric build-up of carbon dioxide and other greenhouse gases, the potential environmental impacts of genetically modified organisms, urban sprawl resulting in loss of habitat and biodiversity, pesticides that might disrupt human endocrine cycles, and the erosion of earth's protective ozone layer in the upper atmosphere.

A point to stress here is that we need to do a better job integrating concerns about manufacturing with other key challenges involving transportation, agriculture, services, consumer lifestyles and consumption patterns. Unfortunately, contemporary societies are not well equipped (either conceptually or organizationally) to bring about this kind of integration. In this paper we have identified structural barriers including uneven development and disarticulated infrastructures. But there are also important political, cultural, and pedagogical barriers. E.O. Wilson (2000) captures this point well. He argues that most of the major problems vexing humanity today,

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<sup>14</sup> WRI et al 1998-1999 World Resources, A Guide to the Global Environment, p. 161

including environmental destruction and endemic poverty--can be solved only by integrating knowledge from the natural sciences with that from the social sciences and humanities. Yet, as Wilson points out:

the vast majority of our political leaders are primarily or exclusively in the social sciences and the humanities, and have little or no knowledge of the natural sciences. The same is true of public intellectuals, columnists, media interrogators, and think-tank gurus. The best of their analyses are careful and responsible, and sometimes correct, but the substantive base of their wisdom is fragmented and lopsided. A balanced perspective cannot be acquired by studying disciplines in pieces; the consilience among them must be pursued.<sup>15</sup>

Striving for consilience is not simply the calling of alienated intellectuals. It can actually be seen now in a wide variety of contexts (what we referred to in this paper as E-shifts), including mainstream science. Below we build on (modify) a recent NSF call for research on integrated urban and regional analysis to suggest an agenda for promoting integrated regionalism in transborder settings:

- Encourage researchers in different disciplines to identify functional relationships, interactions, and linkages among the social, physical, and ecological urban-regional subsystems they study.
- Encourage the development of new regionalism, including models of transborder city-region growth and decline, that integrate social, physical, and ecological components and their interactions at different geographic and temporal scales.
- Identify data shortages, methodological shortcomings, and disciplinary barriers hindering the scientific understanding of the structure and function of city-region systems, particularly those spanning one or more national borders.
- Develop the technical and organizational infrastructure needed to support efforts that are widely distributed, in both the geographical and the intellectual senses.
- Develop data protocols that will facilitate the sharing and use of data by different disciplines and constituencies, and at different spatial and temporal scales.
- Develop information dissemination programs that facilitate the transfer of findings from scientific studies to government officials, educators, business leaders, and the public.<sup>16</sup>

In this paper, we have suggested that building Regional Workbenches is one way to make progress on the agenda items listed above.

### 3. THE WORKBENCH APPROACH

The Workbench approach is an excellent way to provide a gateway to well-organized information, as well as scenarios of how these resources can be used in research projects. The Regional Workbench (RWB) introduced in this paper is being developed in the spirit of several discipline-specific researcher interfaces such as the Biology Workbench (developed at NCSA by Shankar Subramanian), the Sociology Workbench (developed at SDSU by Ilya Zaslavsky - now with the San Diego Supercomputer Center), the Environment Workbench from NASA, Scientist's Workbench from Cornell, etc. The RWB will serve as a web portal for such discipline-specific workbenches (the Sociology Workbench, in particular), linking them with regional-scale data, and presenting students and faculty with an arsenal of research tools in the regional development context.

A good workbench has the following characteristics: searching of data, computation using internal/external resources, joining of complex repositories, uploading of completed research. As it evolves, the RWB website will contain projects, searchable topic maps, data guides, tutorials, and interactive tools for conceptualizing, designing, conducting, and sharing multidisciplinary research. Three broad objectives of the RWB to:

- Provide a mode of communication among University, Industry, Government and Community-based Organizations, thereby enabling an interactive networking of researchers with the end-users of research;
- Integrate research with action for social learning and sustainable development in the San Diego-Tijuana global city-region and beyond (targeting regional planning and policy)

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<sup>15</sup> Edward O. Wilson is the Research Professor and Honorary Curator in Entomology at Harvard University. Two of his books have been awarded the Pulitzer Prize in the general nonfiction category: *On Human Nature* (1978) and *The Ants* (1990). Wilson's article in this issue is taken from his book *Consilience: The Unity of Knowledge*, which was published by Knopf in April 1998

<sup>16</sup> <http://www.nsf.gov/pubs/1998/sbe981/sbe981.htm>

- Develop a series of integrated "topic maps" to facilitate multidisciplinary research (a "topic map" is defined here as coherent group of select knowledge clusters with associated archives, professional and institutional contacts, data sources, data mining tools, metrics, methods and annotated guides for inquiry and action).

The RWB's grand challenge is to enable an innovative synergy of information technology and communication systems with science and policy development. This is a necessary step toward creating more efficient, interactive, and equitable methods for integrating university-based science with the fast-changing needs of industry, government, non-profit and community-based organizations. The RWB aims to add value to, not replicate, existing data warehouses and regional/geographic information systems. The RWB's objective is to build synergy through partnerships by leveraging resources, capitalizing on the expertise of participants, and enabling an integrated approach to research, education, outreach and training. The geographic focus is now on the U.S.-Mexico border, especially Southern California and Baja California. Ultimately, the intent is to create a globally federated network of regionally-based research collaboratives seeking the knowledge, methods and practice necessary to engender sustainable development. University students and faculty, together with community partners, build the RWB's website. Students gain hands-on experience in a manner that emphasizes civic-minded workforce development as well as multidisciplinary scholarship.

The RWB is a web-based "knowledge networking" tool for building a trusted, high-quality, research and action collaborative. The NSF defines knowledge networking as a process of "attaining new levels of knowledge integration, information flow, and interactivity among people, organizations and communities" <<http://www.nsf.gov/kdi>>. The National Research Council's (NRC) Board on Sustainable Development has underscored the vital role of knowledge networking in building regional information systems, a vital component for integrated regional planning:

...a regional scale approach grounded in ecosystem knowledge and cooperative and adaptive management constitutes an infrastructure for social learning—a way to lay out scientific knowledge in a form that can be accessible to non-specialists. As such these systems provide a mode of communication and negotiation that can draw opponents together for learning as well as conflict resolution, allowing learning to continue as action proceeds. Work at the regional scale shows that the way human and natural systems interact can be studied and acted upon in an integrated framework (NRC 1999: 6)

Integrated regionalism will not come about through technical means alone. It requires an ecology of agents whose modus operandi includes peer-reviewed science, state-society synergy, civic engagement and efforts to advance principles of social democracy. On this point we have emphasized the importance of planning support systems (PSS) and the role that universities can play as agents for linking knowledge to action. Along these lines, collaboration and the capacity for consensus building are important regional assets (Innes and Booher 1999). Manuel Castells explains why: "[Collaboration] can be understood as part of the societal response to changing conditions in increasingly networked societies, where power and information are widely distributed where differences in knowledge and values among individuals and communities are growing, and where accomplishing anything significant or innovative requires creating flexible linkages among many players (1996, 1997). Sharing information, knowledge and wisdom in this context is crucial. It is in this light that we have decided to build into the RWB an interactive spatial bibliography of transborder city-regions.

### **An Agenda: Building an On-line Spatial Bibliography of Transborder City-Regions**

The purpose of our spatial bibliography application is to create a navigable resource for comparative study of information organization, planning and management of transborder city-regions. As our analysis showed, a variety of methodological approaches to delimitation, lack of comparable population and other data, and the absence of a consistent framework for comparison, make the task of compiling a trusted list of transborder city-regions nearly impossible. Using population statistics and GIS techniques, we merely arrive at a list of areas predisposed, by virtue of their location, to development of intense crossborder urban interactions. The "spatial bibliography of transborder city-regions" attempts to augment this list of potential crossborder agglomerations with a compendium of studies which detect and describe actual cross-border urban interactions in a variety of geographic conditions. Such case studies have been presented in multiple journal articles and research reports on the topic, and at several conferences, including the "Transnational Planning" track of this year's World Planning Schools Congress.

We organize the spatial bibliography as an interactive Internet map of the world, showing all potential transborder city-regions, plus the transborder agglomerations mentioned in planning and geographic literature

(see <http://www.sdsc.edu/kindred/city-regions/>). From this map, users of the spatial bibliography can navigate to the references and - often - to online reports describing the nature of transborder interaction. As the bibliography grows, the interface will make it possible to develop comparisons and geographic groupings of cross-border city-regions. At the same time, the online map creates a template for accumulating, navigating and integrating various elements of knowledge about particular transborder areas and city-regions. The online interactive map shares the technical foundation with other information and knowledge management approaches discussed in this paper. Meta-information about bibliography entries and locations of city-regions will be preserved as XML (eXtensible Markup Language) files, and the map itself is rendered using XML-based vector markup grammar (Zaslavsky 2000). XML, a new standard for data interchange on the Internet, makes the data accessible for multiple online applications, including the emerging brand of planning support system focused on knowledge navigation and integration. Federating a knowledge-based system of this sort can help link knowledge action collaboatives around the world.

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## Appendix

Name	Country	Capital	Population 1996, mil	Population 2015, mil	Annual Growth 1990-1995, %	Annual Growth 2010-2015, %	Population 2001 <sup>i17</sup>
Calcutta	India	N	12.1	17.3	1.8	2	13790.3
Seoul	Korea Rep	Y	11.8	13	1.9	0.1	19624.5 <sup>ii</sup>
Lagos	Nigeria	Y	10.9	24.6	5.7	3.2	8733.1
Dhaka	Bangladesh	Y	9	19.5	6.4	3.1	9983.1
Essen	Germany	N	6.5	6.6	0.4	0	11308.7 <sup>iii</sup>
Lahore	Pakistan	N	5.2	10	3.6	3.1	5470.0
Santiago	Chile	Y	5	6.1	1.7	0.7	5500.8
Guangzhou	China	N	4.6	7.2	2.7	1.8	5295.1
Toronto	Canada	N	4.4	5.2	2.6	0.5	5411.3
Kinshasa	Zaire	Y	4.4	9.4	4.2	4.1	7272.8 <sup>iv</sup>
Milano	Italy	N	4.2	4.3	-1.6	0	4047.5
Detroit	US	N	3.7	4.1	0.2	0.6	5893.2 <sup>v</sup>
Ho Chi Minh City	Vietnam	N	3.6	4.8	1.7	2.5	5566.9
Berlin	Germany	Y	3.3	3.3	0.2	0	3951.4
Montreal	Canada	N	3.3	3.7	1.4	0.5	3490.6
Koln	Germany	N	3	3.1	0.9	0	11308.7 <sup>3</sup>
San Diego	US	N	2.8	3.4	2.7	0.7	4156.6 <sup>vi</sup>
Chittagong	Bangladesh	N	2.6	4.9	4	3.2	2500.9
Inch'on	Korea Rep	N	2.4	3.5	5.4	0.4	19624.5
Maputo	Mozambique	Y	2.4	5.3	7.6	3.2	1588.9
Toshkent	Uzbekistan	Y	2.3	3.5	1.6	2.4	3331.7
Munchen	Germany	N	2.3	2.3	0.9	0	2342.5
Bucuresti	Romania	Y	2.1	2.2	0.4	0.1	2259.8
Vienna	Austria	Y	2.1	2.1	0.1	0.1	2040.0
Damascus	Syria	Y	2.1	3.5	2.6	2.5	2232.4
Mashhad	Iran	N	2.1	3.7	3.6	2.5	2020.4
Budapest	Hungary	Y	2	2	0	0	2604.1
Tel Aviv-Yafo	Israel	Y	2	2.6	2	0.7	2834.2
Baku	Azerbaijan	Y	1.9	2.3	1.1	1.4	2073.9
Beirut	Lebanon	Y	1.9	2.5	2.9	0.8	1858.6
Vancouver	Canada	N	1.9	2.3	3	0.7	1922.0
Aleppo	Syria	N	1.9	3.3	3.5	2.5	2319.8
Tripoli	Lebanon	N	1.8	3.1	4.5	2.6	2188.8
Cleveland	US	N	1.7	1.9	0.2	0.8	2976.9
Kharkov	Ukraine	N	1.7	1.7	0.7	0	1692.7
Conakry	Guinea	Y	1.6	3.5	6.6	3.9	1565.2
T'bilisi	Georgia	Y	1.4	1.5	1	0.7	1449.6
Torino	Italy	N	1.3	1.3	-1.5	0	1619.4
Yerevan	Armenia	Y	1.3	1.5	1.1	0.8	1432.0
Almaty	Kazakhstan	Y	1.3	1.5	1.4	1.2	1222.4

La Paz	Bolivia	Y	1.3	2.1	3.6	2.2	1609.2
Donets'k	Ukraine	N	1.2	1.2	0.5	0	1764.0
Beograd	Serbia	Y	1.2	1.3	0.7	0.5	1697.8
Praha	Czech Repub	Y	1.2	1.2	0.2	0	1380.5
Amman	Jordan	Y	1.2	2.3	4.3	2.5	2443.5
Sofiya	Bulgaria	Y	1.2	1.2	0	0	1192.6
Bruxelles	Belgium	Y	1.1	1.1	-0.5	0	1737.2
Al Kuwayt	Kuwait	Y	1.1	1.5	0	1.2	1651.3
Odessa	Ukraine	N	1.1	1.1	0.3	0	1121.5
Rostov-na-Donu	Russia	N	1.1	1	0.4	0	1254.4
Rotterdam	Netherlands	N	1.1	1.1	0.3	0	1125.5
Asuncion	Paraguay	Y	1.1	2	3.1	2.7	1427.1
Khulna	Bangladesh	N	1.1	2	3.5	3.3	1168.8
Ottawa	Canada	Y	1	1.2	2.3	0.7	1060.4
Brazzaville	Congo	Y	1	2.1	4.8	3.3	7272.8 <sup>4</sup>

List of urban agglomerations with population over 1 mil (1996) located within 50 miles from an international border. Population estimates from "Urban Agglomerations 1996", United Nations publication, ST/ESA/SER.A/163, United Nations 1997 (on the web at <http://www.undp.org/popin/wdtrends/urb/urb.htm>)

Missing from the list are the following transborder urban agglomerations (population data, in thousand, from 2001 World Gazetteer, [www.world-gazetteer.com/st/statn.htm](http://www.world-gazetteer.com/st/statn.htm)):

Singapore-Johor Bahru (Singapore/Malaysia):	4511.8
København-Malmö (Denmark/Sweden)	2313.5
Ciudad Juárez -El Paso (Mexico/USA):	1979.5
Lille-Kortrijk (France/Belgium):	1721.4
Buffalo - Saint Catharines (USA/Canada):	1555.5
Dandong-Sineuiju (China/North Korea)	1472.3
Saarbrücken-Forbach (Germany/France):	1099.8
Aachen-Heerlen-Maastricht (Germany/Netherlands/Belgium):	1099.3

<sup>i</sup> Source: World Gazetteer, [www.world-gazetteer.com/st/statn.htm](http://www.world-gazetteer.com/st/statn.htm)

<sup>ii</sup> Seoul agglomeration includes Inch'on.

<sup>iii</sup> The Rhein-Ruhr agglomeration

<sup>iv</sup> The Kinshasa-Brazzaville agglomeration

<sup>v</sup> Detroit-Windsor agglomeration

<sup>vi</sup> San Diego-Tijuana transborder city-region