Conceptualizing Anthropogenic Change in Fluvial Systems: Drainage Development on the Upper Embarras River, Illinois

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While the geomorphic structure of many landscapes is materially molded, shaped and transformed by human practices, it is at the same time experienced and perceived through the mediation of cultural discourse and representation. The objective of this article is twofold: (1) to establish a conceptual framework for integrated analysis of human and geomorphic dimensions of landscape change; and (2) to illustrate the use of this framework in the assessment of a physical system severely affected by human agency. This perspective offers one way in which human agency can be synthesized and integrated into aspects of physical geography—specifically fluvial geomorphology—from both a conceptual and a pragmatic point of view. The upper Embarras River in east central Illinois, used as a case study, has been and continues to be physically affected by the cultural practice of agricultural drainage over the past century and a half. Key words: environmental management, geomorphology, human agency, landscape change.

We all feel ... that somewhere in geography there is a fundamental unity which eludes us. Is not our difficulty how to weld together the geological and the human aspects of the subject? ... Is it not perhaps the lure of geomorphology which has been misleading us? (Mackinder 1931, 323)

Geography is commonly portrayed as a discipline that spans both the physical and social sciences, with the interface between humans and the biophysical environment at its core (Jones 1983; Dilsaver and Colten 1992). Part of what makes our discipline theoretically distinctive, coherent, and relevant is the emphasis placed on transcending the traditional boundaries existing between natural science, social science, and the humanities (National Research Council 1997b). In many ways, though, the promise of a geography that integrates the physical and human remains just that—a promise. Contemporary geography functions more as two distinct disciplines than as a coherent whole unified around a human-environment core (Johnston 1997). Geography has grown increasingly compartmentalized within its subdisciplines, with little synthesis occurring across these boundaries (Gober 2000).

The issue of integration and unity is of interest because, as a discipline, while we frequently state that geography illuminates the interconnections between humans and the biophysical world, we have fallen short of our potential in actually developing a body of knowledge or theory concerning those interconnections (Rhoads 1999). While Trimble (1992, xviii) speaks of the human-physical interface as a major strength of geography, he also labels it “Terra Incognita” and “no-man’s land.” Some connections across the human-physical geography interface have been made, yet there has been little or no integration of physical and sociocultural processes (Goudie 1986; Johnston 1997).

A more pragmatic reason for examining integration and disciplinary unity is provided by the growing trend in American science policy towards focusing on research pathways that stress the linkages between biotic, social, and environmental dynamics (Gober 2000). In 1997, the National Research Council (NRC) studied the nation’s research activity focused on the environment and advocated a more comprehensive and integrated approach (National Research Council 1997a). In recommending a core research agenda for the U.S. Environmental Protection Agency (EPA), the NRC highlighted the need for an understanding of the social and economic aspects of human interactions with the environment and how they mediate our behavior with the physical, chemical, and biological dynamics involved (Kolb 1998). At the core of such an approach is the true integration of sociocultural process and biophysical process into a single conceptual framework, not the arrangement of two separate approaches welded together. Geography has the potential to fill this niche in the national re-
search program while still being faithful to disciplinary traditions and strengths, instead of viewing sociocultural processes as tertiary components of environmental systems (Graf et al. 1980; Rhoads et al. 1999).

However, there is no clear, prescribed route into this territory. For example, applied studies in geomorphology have attempted to combine societal issues with physically based geomorphic knowledge and have been lauded as one of the primary linkages between human and physical geography (Goudie 1986). Studies of this type do address both biophysical and societal concerns and contain the disciplinary roots for hazards research and geomorphological approaches to environmental management (Hart 1986). However, such studies are not truly integrative, in that they tend to be pragmatically oriented towards applying knowledge, techniques, or tools to solve environmental problems identified by society or a subset of society (Coates 1990). By focusing on management issues or mitigation of environmental hazards, applied geography often offers normative prescriptions for human behavior or biophysical adjustment based upon unchallenged assumptions concerning the desirability of certain outcomes. Hart (1986, 136) describes the idea that humans and the landscape form a mutually interacting system as “an attractively simple one.” Yet, like Goudie (1986), Hart restricts the implementation of this idea to hazards research and environmental management as they define applied geomorphology. While human impacts upon the environment or environmental impacts upon society are core concerns in environmental geomorphology (Coates 1990), these studies are grounded in the assumption that human processes are external to the environmental system.

Land drainage and river channelization have substantially impacted fluvial landscapes throughout the period of human existence on the planet (Brookes 1988). Large-scale drainage of landscapes has been occurring for centuries in Hungary, Italy, France, the Netherlands, Great Britain, and the United States, resulting in a functional change in the hydrologic parameters of these biophysical systems (Marsh 1874; Klimm 1956; Glacken 1967; Tinkler 1985; Butlin 1990; Trimble and Cooke 1991; Shallat 1994; Schama 1995). In 1930, total farmland drained for agriculture in the United States was estimated to be 180,185 km² nationwide, over 20 percent of which lay in the state of Illinois (McCorvie and Lant 1993). By 1973, this figure exceeded 526,103 km² (Soil Conservation Service 1973). Even so, geomorphic investigations exploring the dynamics of human agency are few (Walker 1993; Hooke 1994, 1999, 2000). For the most part, geomorphic research has purposefully sought out “unspoiled” environments to better understand how natural biophysical systems operate independent of human influence (Trimble 1992). This bias reinforces the conception that humans are alienated from nature (Fitzsimmons 1989; Soper 1995) and limits our vision of the full range of processes, both biophysical and cultural, effecting change upon the environment.

The goal of this article is twofold: (1) to establish a conceptual framework to guide integrated analysis of human and biophysical dimensions of landscape change in physical geography; and (2) to demonstrate how such an analysis can generate an understanding of landscape change transcending that which is likely to emerge from separate investigations of social and biophysical processes. Underlying this conceptual framework is an analysis of the philosophical and theoretical foundations behind the separation of humans and society from the biophysical geomorphic system and the reconstruction of the system to include humans and human agency. This approach offers one way in which human agency can be integrated into aspects of physical geography—specifically, fluvial geomorphology—from both a conceptual and a pragmatic point of view. Integration of the human and biophysical at a fundamental level cannot have any chance at ultimate success unless the distinctions currently made between the two are clarified, challenged, broken down, and reconstructed.

The proposed conceptual model provides a framework to guide the investigation of human-modified biophysical landscapes from an anthropogeomorphic perspective. In a sense, it is an attempt to navigate Trimble’s (1992) “terra incognita” by extending the process in process geomorphology to include human dynamics alongside the more traditional biological, chemical, and physical processes (Gregory 2000). The intent is not to provide an alternate way of viewing human impact on the environment; rather, the model is offered as a means of ac-
cessing the examination of human influence within the biophysical environment. As such, it is primarily based on the following assumptions: (1) humans can operate as both internal and external components of local geomorphological systems; (2) human behavior is an effective agent of biophysical change; (3) human behavior is influenced by the biophysical environment through the act of perception, personal experience, and the generation of local and scientific knowledge; and (4) linking human agency to biophysical processes is as much an exercise in theoretical geomorphology as it is applied geomorphology.

To illustrate the model, the recent evolution of the upper Embarras River basin in east central Illinois is used as an example of a real landscape affected by human agency. As in temperate ecosystems unmodified by human agency, summertime here gives witness to endless tracts of lush vegetation. East central Illinois however, is not a typical natural ecosystem. The vast homogeneity of corn and soybeans and the factory-like way the landscape is managed challenges traditional notions of natural. While the sowing of crops every spring may be the product of social, cultural, and economic forces operating independently of the biophysical environment, their growth and eventual maturity inevitably rely on biophysical processes. Similarly, regional drainages are often dismissed as managed ditches, yet still erode, transport, and store sediment via the same physical principles as do pristine streams. The heavily modified upper Embarras River basin provides an excellent case study for the interaction of cultural and biophysical processes over time and how these interactions, in turn, shape the structure and function of the fluvial landscape.

Reconceptualizing Human Agency

The role of humans in altering the structure and function of the environment has long been a topic of interest to geographers (Marsh 1874; Thomas 1956; Gregory 2000). What has been lacking is the development of theoretical approaches linking human agency to humans themselves. Given the long-standing philosophical legacy of separation between sociocultural phenomena and those referred to as natural (Katz and Kirby 1991; Soper 1995), the rubric of physical geographers has rarely included research questions concerning internal human dynamics as they impact the biophysical environment (Jones 1983; Nir 1983). An a priori distinction is made between cultural landscapes and biophysical environments; cultural landscapes are the bailiwick of social science (human geography), while biophysical environments are the realm of natural science (physical geography). Geomorphology, a subfield of physical geography, has identified itself as a natural or physical science, fundamentally concerned with objects and processes acting independent of human consciousness (Strahler 1980; Nir). While the impacts of human agency have been widely documented, geomorphic studies traditionally have proceeded from the disturbance event instead of incorporating the dynamics of human agency itself into the functional system (e.g., Graf 1977). Yet, since most environmental problems humans face today are as much social phenomena as physical (Evernden 1992), separating the two may result in applied solutions that are one-dimensional and incomplete (Roe 1996).

Nonetheless, there are a number of pragmatic reasons for this human-physical separation within geography. A host of time-scale and space-time linkage problems accompany the examination of historical human interactions with the biophysical environment (Phillips 1997). From a systems perspective, there is also a quantitative-qualitative data mismatch that must be addressed. All levels of systems analysis can be viewed using quantitative data except for those where cybernetic feedback necessitates social and cultural investigation into perception and meaning (Ashby 1958). Understanding human motivations and behavior is an inherently descriptive undertaking that tends to defy quantification. Relating this qualitative data in a meaningful way to other levels of systems analysis is a challenge (Pickles 1985).

If we are to examine human agency as a process and understand not only how but also why it impacts the biophysical environment, we must reconcile human society and culture with biophysical nature. The separation of human and physical geography is premised upon the abstraction of nature from society, “nature existing without social meaning” (Fitzsimmons 1989, 111; Greider and Garkovich 1994; Simmons 1994; von Maltzahn 1994). As Colwell (1987, 112) has stated, “dualism is more than
the philosophers’ contrivance; it is a fundamental expression of the entire sweep of modern culture.” Underlying the semantics involved is a dispute over “the legitimate and logically consistent ways to view human activities with respect to the rest of the natural world” (McIsaac and Brun 1999, 2). Simply put, the science of nature is based on the idea of nature (Collingwood 1945). Since geomorphology is a composite science, grounded in part within physics and chemistry, the concept of nature as defined by the natural sciences fundamentally affects geomorphology (Osterkamp and Hupp 1996; Katz 1997).

For millennia, Western philosophical thought has been punctuated by speculation about where humans fit in the world and what role we play. How we choose to define the concept of nature mediates the ways in which we order the world. Explicitly defining what it means to be human or natural effectively clarifies our relationship to the cosmos. Defining Nature as “that which is not human” places it in opposition to us. Our ideas about both the “other” and ourselves have been built upon this distinction. The Western tradition of separating humans from the biophysical has its immediate roots in the mind-body dualism of Descartes, but the nature-culture distinction can be traced back at least as far as the sixth and seventh centuries BC (Glacken 1967).

The metaphysical framework of Cartesian dualism underlies the two main themes that have defined views of nature and influenced science in the Modern period (Soper 1995). The first refers to the forms, processes, relations, and causal powers operating in the biophysical realm, which have traditionally provided the objects of study for the physical or natural sciences (Soper). In this view, nature is synonymous with “normal.” Forms in nature are permanent, recurring phenomena generated by environmental forces objectively perceived by humans from outside the system. The second theme refers to nature as the ordinary observable features or objects of the world, such as animals, landforms, plant assemblages, and so on. This is the nature of immediate experience and aesthetic appreciation, what we see, feel, hear, and touch in our interactions with the world around us. Both of these themes objectify and externalize nature from human influence (Castree and Braun 1998). Human agency becomes a “disturbance,” despoiling not only the natural function of the environment but also the features and objects which comprise it.

Because a disconnection has been made between the physical objects of science and the cultural objects of people, most scientific endeavors have been intellectually distant from the embodied consciousness of humans (Pickles 1985). Phenomenology, a philosophical orientation described by Husserl and later expanded by philosophers such as Heidegger, Sartre, and Merleau-Ponty, was originally put forth as a means to ground the foundation of the scientific endeavor in the everyday lived experience of the human lifeworld (Merleau-Ponty 1968; Macann 1993). Phenomenological philosophy matured in the late 1800s with the writings of Husserl (1962, 17), who desired to return scientific inquiry to “the things themselves.” The phenomena or “things” in question are those mental life constructs inherent in all people, including “thinkings, judgings, believings, doubtings, perceivings, willings, strivings, feelings;” all that Descartes included under the umbrella of cogito (Kersten 1989, 19). Husserl defined pure phenomenology as a descriptive endeavor “that seeks to render a cognitive account of the ‘irreality’ of mental life processes” (Kersten, 87).

Disciplines such as environmental management, ecology, and geomorphology—sciences in which cultural values, meanings, and personal experience interact with the physical structure and function of the biophysical world—can reap the benefits of a phenomenological approach (Howarth 1995). Phenomenology can be useful in affording us a philosophical orientation for reexamining the relationship of people to the biophysical world that lies at the core of geographical inquiry, environmental ethics, and environmental management. In dualistic philosophy, nature becomes distinct from culture, physical geography distances itself from human, and the natural and social sciences bifurcate (Evernden 1992; Lease 1995). Phenomenology rejects these notions and grounds the scientific endeavor in embodied consciousness.

Past advocates of phenomenology, especially in geography, have perpetuated the mistaken view that it is: (1) an ideographic perspective not relevant to phenomena at the aggregate or regional level; (2) subjective and relativist; and
antiscientific or nonscientific. However, the works of phenomenological philosophers such as Husserl, Heidegger, and Merleau-Ponty do not support these views (Pickles 1985). To Husserl and the other phenomenological philosophers, although science does not necessarily have a privileged position in “knowing the world,” it does hold a distinctive position (Kockelmans 1966). Scientific knowledge is different than experiential knowledge, but it is always grounded in subjective embodiment (Spurling 1977).

By acknowledging the process of perception and the creation of meaning in the human psyche we are not socially constructing nature so much as we are socially mediating our relationship with the environment via the perceptions, values, and ethical positions that define our lifeworld. As biological animals, our access to a reality external to our consciousness is limited in certain ways. Our consciousness is embodied, connected to the rest of nature, because we are part of the reality we are trying to access (Merleau-Ponty 1968). The act of perception and our contextualizing that perception is colored by our worldview, knowledge base, and past experiences, which in turn affect the way we interact and behave toward the world (Abram 1996). Instead of perception being a strictly intellectual experience, it is described as existing in the interplay between the visible, sensible environment and the invisible realm of thoughts, emotions, values, and knowledge.

The phenomenological project does not dispute the character and nature of the sciences intent upon analysis and description of the physical world. Instead, it focuses on the ways in which we, as thinking, embodied humans, experience and access the totality of phenomena existing outside of ourselves. According to Husserl and Merleau-Ponty, behavior, perception, and experiences cannot be accounted for solely by mental and cognitive processes detached from the physical world, or by naturalistic impulses which view the biological machinations of the human animal as having explanatory power (Schrag 1967; Pickles 1985). Experiences, values, ethics, perceptions, and behavior are mediated by past experiences, perceptions, sociohistorical context and the embodied consciousness of the individual (Rhoads et al. 1999). This process is not limited to naive constructions of the world; it is the foundational way in which we all—scientists as well as nonscientists—experience and perceive the world. A phenomenological view of science speaks to the ability of that science to be relevant to human subjectiveness and concerns by conducting itself within this embodied contextuality. Situating ourselves within nature and the environment opens the door for science to become involved in the debate regarding what action or behavior is desirable or appropriate at a level transcending personal subjectivity.

Constructing a Model of Human Agency in Geomorphology

There is far more common ground at the theoretical level between the current practice of geomorphology and social theory than is initially apparent. Both are interested in representing reality through internal and external dynamics. Both ask similar questions about subjects or events they encounter: by what process was it constituted and how is it sustained? Both go beyond mere description or correlation between phenomena and venture into the realm of trying to understand the process underlying the phenomena. Lastly, both are constrained by the fact that, while process may be the object of interest, the easiest way to access those processes is through the objects or set of structures they create. As stated by Merleau-Ponty (1968, 216), “the visible is pregnant with the invisible . . . to comprehend fully the visible relations one must go unto the relation of the visible with the invisible.” At the human-environment interface, the “invisible” encompasses those cultural and biophysical processes that create or alter both individual and collective worldviews and the visible landscape.

As implied by the name, process geomorphology as it has been practiced since the 1950s has had the same impulse towards process and the nature of relations between objects as dialectics that has characterized the discipline since G. K. Gilbert and W. M. Davis. However, it is more formally linked with the general systems theory of von Bertalanffy than with the informal use of the term employed by either Gilbert or Davis (Gregory 1985; Thorn 1988). Control systems dominated by cybernetic feedback are the highest, most complex of the five levels of systems analysis (Strahler 1980). Control systems are essentially process-response
Drainage Development on the Upper Embarras River, Illinois

systems with an additional, intelligent feedback mechanism added. Strahler describes cybernetic feedback as a high-level systems function designed to elicit a certain type of system response. Human decisionmaking and behavior act to regulate the system in some intentional way. While unintended human impacts upon systems have most often been accounted for in level four (Thorn 1988), many of these impacts are ultimately tied to decisions made to elicit some type of response and can therefore be classed as cybernetic feedback even if the exact response generated is different than the intended goal.

Although the physical effects of human interaction with the environment have been widely studied at the systemic level by geomorphologists, the valuations, perceptions, and behaviors that initiate this change and drive cybernetic feedback have been largely overlooked (Jones 1983). With their mutual emphasis on the flux of forces and relations, geomorphological systems theory and the dialectics of social theory can be combined to form a coherent, process-based view of how biophysical landscapes in human-modified environments have coevolved with human culture through mutual symbiosis.

The conduct of science and scientific observation itself is theory-laden (Rhoads and Thorn 1994, 1996). As such, it is necessary to clarify new philosophical and theoretical positions if we are to challenge the traditional assumptions under which the science of geomorphology has operated. The conceptual model developed for this project (Figure 1) draws on a critical realist perspective grounded in phenomenology to define biophysical landscape as the “articulated moment” resulting from a system of anthropic, physical, and chemical impulses interacting with the material reality of the environment and each other (Schein 1997).

A landscape described by this model is a snapshot of existing conditions at that given time. It should not be viewed as a static description of landscape form, but rather as a way of interrelating the various dynamic processes that are constantly adjusting the observed form. Viewed in this way, the physical landscape at the center of the model becomes a transitory artifact of past processes. It is never truly constant because it is always in the process of becoming. Because the model is iterative, investigative entry into the model can occur at any point.

![Figure 1](image)

**Figure 1** Conceptualized framework for integrating human agency into the geomorphic system in heavily modified landscapes.
Where one starts is less critical than the web of subsequent relations outlined.

In this model, as in a Venn diagram, the purely biophysical environment overlaps with the human world of culture and society to create an area that contains the physical structure of the environment, invested with meaning, at any given moment in time (Venn 1971). In this way, the biophysical environment becomes as much a cultural entity as a biophysical one, in the sense that the landscape contains and reflects the types of behavior determined to be ethically appropriate by the local community (Cosgrove 1989; Greider and Garkovich 1994; Rhoads et al. 1999). While this is similar to conceptual models developed by others such as Slaymaker and Spencer (1998), it moves beyond pointing to an area of overlapping influence between humans and the rest of biophysical nature by detailing some of the objects and potential pathways found in that relationship. The type and extent of human interaction with the landscape will vary from place to place and is contingent on local sociocultural dynamics operating within the community as well as on the biophysical setting within which the landscape is set.

To the left, the loop indicates social processes that may ultimately influence the physical state of the landscape. These anthropic forces are guided by social processes involving perception, valuation, assignation of meaning, and the negotiation of ethical positions mediating human behavior (Aitken 1992). The effect human agency has on the environment is limited here to direct modification and does not include indirect effects to simplify the relationship between behavior, environmental change, and cybernetic feedback.

Since the model as a whole represents a control system, cybernetic feedback is utilized to maintain or adjust human behavior towards the environment for some purpose. Our understanding of the biophysical landscape is thereby initially conditioned by what we perceive and experience and informed by scientific knowledge. Before this can affect the physical structure of the landscape through human agency, these inputs of local and scientific knowledge are contextualized and interpreted by a complex of past perceptions, experiences, and valuations. Problems are identified, remedies are considered, and responses are made according to feasibility and ethical or societal acceptability.

On the right hand side of Figure 1, environmental impulses interact to generate systemic change or lead to morphologic stability. These forces are characterized by the traditional physical, chemical, and biological processes effecting geomorphic change (Gregory 1985). When joined with human agency in the center, the biophysical system becomes a control system. If the impact is of significant magnitude, human behavior elicits a complex systemic response (Schumm 1991). Depending on the nature, extent, and magnitude of the impact and the sensitivity of the environment to these perturbations, feedback mechanisms may dampen or undermine system stability (Downs and Gregory 1993). Any resulting physical alterations to landscape function or structure are then fed back into the left-hand side of the model through experience and perception.

While this model is intended as a general way to conceptualize landscapes by internalizing humans as agents of biophysical change, its utility will not be as great for landscapes relatively isolated from human influence. The left side of the diagram would not be relevant for systems operating outside of the influence of humans. The processes and impulses traveling through the right half of the diagram would dominate systems experiencing minor anthropogenic inputs. As shown, the model is a generalized view of the processes involved on both sides. The level of integration between both sides will ultimately depend on the magnitude and frequency of the impulses involved in a local system. In a low-energy biophysical environment that is impacted by high-magnitude, high-frequency anthropogenic events, the overlap between the two sides will be great, since, under these conditions, humans play a substantive role in shaping the biophysical landscape. In a high-energy biophysical environment where anthropogenic impulses tend to be low-magnitude and low-frequency, human agency will have a more subtle role in shaping the biophysical landscape at any given time. Instead of viewing human agency as a binary—either “not important” or “important”—this model allows us to track the effectiveness of human agency on a continuum by exposing the efficacy of human agency.

The conceptual model is not intended to challenge the fundamental nature of these systems, but rather to expand the scope of the
Drainage Development on the Upper Embarras River, Illinois

systems perspective to include anthropogenic impulses as an important process that effects change in geomorphic systems for some express purpose. It is meant to reflect the hierarchical complexity inherent in such systems contingent on the scale of investigation. The anthropogenic component may be both internal and external to the system depending on the scale of the analysis. At the local level, the worldviews and land ethics of communities and individuals are affected by perceptions of and experiences with the local biophysical landscape. As long as there is feedback in the form of experiential or scientific knowledge of a landscape, the human element can be considered internal to that system. At the same time, there may also be societal constraints upon environmental modification in the form of rules, regulations, or ethical norms. Society or culture defined at this larger scale would not normally directly receive feedback from local systems and, in this way, can be considered external. In this context, anthropogenic processes, along with the spatial and temporal scale linkages between the biophysical processes, can be viewed as hierarchically nested (deBoer 1992).

**The Upper Embarras River**

Figure 1 was utilized as a holistic way to theoretically insert human agency into the function and evolution of the upper Embarras River channel since the advent of large-scale agricultural drainage in the mid-nineteenth century in Illinois. Some results of this project are discussed here to demonstrate the utility of the model in guiding this research. The study area for this project was restricted to a 288-km² area in southern Champaign County in the upper Embarras River basin (Figure 2). The river itself rises south of Champaign-Urbana in Champaign County and runs south approximately 312 km before flowing into the Wabash River near Vincennes, Indiana. The upper basin is especially dominated by row-crop agriculture, which accounts for over 91 percent of the total land cover (Luman 1997), and has been extensively tiled and channelized over the past 150 years. It contains some of the most

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**Figure 2** Location of the upper Embarras River basin.
productive soils in Illinois (Barnhardt 1997). Another characteristic of the basin is the lack of topographic relief. Typical stream gradients are on the order of 0.0001 to 0.001 (Rhoads and Herricks 1996). The combination of flatness, low permeability of the underlying fine-textured sediments, and the lack of extensive drainage dissection results in the propensity of large areas of the basin to exhibit high water tables, high rates of overland flow, and frequent flooding (Barnhardt 1997).

Three major areas of investigation were implemented to flesh out the connections illustrated in Figure 1: (1) construction of an environmental history documenting the legacy of past perceptions, meanings, and valuations that led to the agricultural drainage dominating the upper Embarras basin today; (2) contemporary analysis of farmer perceptions and valuations of the local environment using phenomenological reduction and in-depth interviewing; and (3) long-term photogrammetric assessment of planform change due to stream straightening. The scale of interest for this study is the planform scale of fluvial dynamics in the watershed. While the biophysical environment has arguably been altered in many ways by many groups in the past century and a half, I limited this investigation to farmers and drainage district activities altering channel dimensions and the stream planform though subsurface drainage and stream channelization.

**Sociocultural Context**

Wetlands, swamps, and marshes were landscapes that had been demonized among Europeans for hundreds of years. In Medieval vision literature, hell is often portrayed as a frozen swamp (Miller 1989). English settlers in New England saw these landscapes as “clearly sinister” (Vileisis 1997, 34). Settlers arriving in east central Illinois for the first time invoked many of these popular images to explain the awe-inspiring sight of unbroken prairie (Schoolcraft 1825; Armstrong Robertson and Riker 1942). Accounts of the Grand Prairie by those who traveled across it in the 1820s and 1830s describe vast areas of grass as high as a man on horseback and standing water that not only was extremely difficult to traverse, but also bred populations of mosquitoes, black flies, midges, crane flies, aphids, and moths so thick they darkened the air (Winsor 1987; Whitney 1994).

The few travelers that made their way across the Grand Prairie in the early nineteenth century did so mostly in the wet spring months, and this undoubtedly contributed to the popular perception that east central Illinois was mostly swampland. Wetness was, indeed, considered the most pervasive trait of the east central Illinois landscape, and no doubt led to it being the last region of the state to be settled (Winsor 1987).

Once settlement began, the high incidence of medical problems and disease-related fatalities in those who lived in or near wetlands in the nineteenth century fed into all of the popular stereotypes of the wetland as a sinister, sinful place (Miller 1989). Though the biological vectors transmitting such diseases as malaria, yellow fever, and cholera were not understood until almost the turn of the century, people were observant enough to correlate wetlands and disease (Prince 1997). Something about wetlands was unhealthy. While this perception was initially an important deterrent to the large-scale settlement of wetland landscapes, once the productive fertility of their soils was discovered, the threat of disease became powerful leverage for their drainage (Billingsley 1898; Lewis 1922). The elimination of these diseases ultimately became a triumph of drainage and progressive farming in Champaign County and the Grand Prairie (Billingsley 1891; Cunningham 1905; *Southern Drainage Journal* 1919).

The actual method of draining agricultural land usually went through a progression on east central Illinois farms that started with mole drains and progressed to the excavation of small, open ditches normally about two feet deep alongside fields, the installation of subsurface tile, and finally the dredging of stream channels (Winsor 1975). This progression occurred as drainage technology advanced, farmers experienced or perceived the benefits of drainage, and their means to install drainage works increased. As drainage in the fields became more efficient, the importance of having good outlets into which subsurface tile could convey excess water became critical (Bogue 1939). Investments in drainage tile would not pay off until there were adequate outlets (Shaw 1908). Clearing existing stream channels of vegetation, obstructions, and snags was the first step in improving outlets. If these measures
Drainage Development on the Upper Embarras River, Illinois

were not effective, “channel correction” in the form of channel-straightening, dredging, and widening was performed (Pickels and Leonard 1929). Drainage, both subsurface and surface, became the primary way in which farmers could not only improve the value of the land they farmed but also ensure the reduction of health threats such as malaria. The impact on regional streams was enormous. Within the Embarras River basin, it has been estimated that over 67 percent of all second-order streams have been subject to channelization (Mattingly, Herricks, and Johnson 1993). Other regional streams such as the Kaskaskia River have been even more severely impacted.

Predominant Community Land Ethic

In the eleven-month period from October 1996 to September 1997, twenty-seven interviews were performed with drainage district commissioners, farmers, engineers, and others associated with farming in Champaign County, Illinois. While most subjects were from the Embarras River watershed, a minority resided in adjacent basins such as the Kaskaskia, Sangamon, and Salt Fork. Open-ended, in-depth interviews were the main methodological tool used in the reconstruction of meanings, perceptions, and ethical positions held by actors within the upper Embarras River basin. The purpose of the interviews conducted was not reconstruction of “life-history” or knowledge about specific events and activities, but rather an understanding of the meanings generated in subject-experience (Taylor and Bogdan 1984; Wilson and Slack 1989). Drainage was one of the focus areas of the interviews conducted for this research. Questions revolved around the practice and activity of drainage, as well as the state of drainage existing on the farm or within the drainage district.

The interviews resulted in a number of perceptual themes illustrating different ways in which producers and drainage district commissioners in east central Illinois perceive and conceive the surrounding landscape. One such theme is that a farming aesthetic exists among producers in the upper Embarras basin, characterized by visual cues of order and neatness. Agricultural drainage is an important local component of this aesthetic, in that straight, unvegetated ditches reinforce the orderly aspects of the efficient farm operation. The appearance of ditches transcends the utility of the streams as conveyances of water; it becomes a personal reflection of the farmers’ values and their ability to efficiently run the farm operation. In effect, streams become part of a complex means of communication between individual farmers and the rest of the farming community.

Geomorphic Response

The concept of equivalent geomorphic efficacy was used as a way of comparing human-induced stream change due to channelization with environmental change driven by normal meander extension/downvalley translation or response to channel-straightening (Rhoads and Urban 1997). Equivalent geomorphic efficacy allows for the approximate comparison of the extent and magnitude of very different sets of forces acting on the physical landscape. It creates a middle-ground index where the physical effects of human agency can be assessed in the same terms as other biophysical processes effecting morphologic change.

By digitally capturing and analyzing photogrammetric information to assess planform change, we can conclude that human agency has without doubt had an impact on the stream planform of the Embarras River and its tributaries over the past sixty-three years. At the scale of both channel geometry and planform adjustment, the Embarras River has been severely impacted by the anthropogenic effects of channel-straightening occurring within the basin. Between 1936 and 1940, approximately 13,656.8 m of the main stem of the Embarras River were altered. Channel-straightening for the express purpose of maintaining agricultural drainage directly accounted for 75.3 percent of all areal change in stream channel planform detected throughout the basin over the period of record.

Conclusions

Perhaps Mackinder (1931) was correct in suggesting that geomorphology was mistakenly being viewed as the component of geography melding the human and the biophysical aspects of the subject. After all, it is nothing inherent in the study of geomorphology that allows us to freely range into Trimble’s (1992) “terra incognita.” Rather, it is the ontic and epistemic views and perspectives we bring to the study of geo-
morphology that ultimately have the power to serve as navigational tools guiding us through this unknown landscape. Not until we begin to challenge traditional assumptions that ground our science (human geography is distinct from physical, “nature” is a taxonomic classification of items, humans are external to the biophysical environment) do we begin to see the philosophical flaws in these assumptions and the degrees to which they have affected us.

The conception of Figure 1 was grounded in the challenge to both humanize the local landscape and, at the same time, return it to nature. Both human and biophysical processes act in concert with one another, exerting force on geomorphic and ecological aspects of the landscape. While streams in east central Illinois have been influenced by the cultural legacies of drainage and channelization, they do still function as part of the biophysical system, self-adjusting to prevailing conditions by eroding, transporting, and storing sediment (Rhoads and Herricks 1996). Altering the environmental parameters of the fluvial system does not make it any less a fluvial system.

**Literature Cited**


Drainage Development on the Upper Embarras River, Illinois


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