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Research Article

THE CHARACTERISTICS AND FUNCTION OF THE FLUVIAL ECOSYSTEM -A COMMON INTERACTIVE PLATFORM FOR MANKIND AND NATURE

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ABSTRACT
Fluvial ecosystems have many features, a colorful platform of the interactions between human being and environment which including inorganic and organic resources. Forest hydrology and stream/river hydraulics make the ecosystem alive. Aquatic lifecycle depends deeply on the flows, such as water depth, width of channel, flow velocity, material of channel bed and slope of stream/river, to transport nutrient.
In this paper, the characteristics of fluvial ecosystem with its variable factors will be illustrated first. Then the functions of fluvial ecosystem are following. Finally, the impact mechanisms resulting uncertainties on the platform are emphasized with their conceptual solving strategies.

Keywords: *Aquatic; Ecosystem; Fluvial; Hydraulics; Hydrology; River; Stream; Uncertainty*

INTRODUCTION
Water is a valuable resource for humans and provides essential habitat for many organisms. Aquatic habitat is influenced by processes active with the flows not only in the near-stream riparian zone but also over the entire watershed. Fluvial ecosystems have many features and river (or stream), the water body with velocity, plays a very important role. Rivers have an intact floodplain exchange organic matter and nutrients with the adjacent land, and all fluvial ecosystems high connectivity laterally, vertically, and longitudinally. River science attempts to catalogue and understand how those diversity processes interact with different environmental settings and across scale from the smallest headwater streams to great rivers. Numerous classification systems for rivers have been developed as guide management activities including restoration and assessments of river health. Climate, source of flow, geology, and landform exert particular control on the river basin and network development, set the domain of interacting geomorphic and process to shape channels and features at the segment to reach scale.
In any ecosystem, nutrient cycling describes the uptake of some nutrient, usually from a dissolved inorganic phase, and its subsequent incorporation into biological tissue and consume by excretion or respiration to completing the cycle.
The hydraulic characteristics of flow through channels are an important component of aquatic habitat evolving in stream systems in which water velocity and flow depth vary spatially within the watershed and temporally on a daily, seasonal, and annual basis. Flow requirements vary during different phases of the freshwater life cycle of aquatic. The life cycles of fish species have adapted to the temporal variations in flow conditions by timing the phases of the life cycle to take advantage of the seasonal discharge characteristics. Spatial variability enhances species diversity by creating a variety of habitats within stream reaches. Velocity may often be the factor limiting available habitat space. Hawkins, *et al.* (1993) mentioned "channel components such as pools, riffles, steps, cascades, and plane beds provide important habitat for many organisms. Variations in the hydraulic characteristics of different reaches and channel sub-units create distinctive habitat characteristics that influence the spatial distributions of aquatic organisms". Channel morphology is formed largely by sediment and water input to the channels lining the channel bed with shapes of riffles, pools, and boulder cascades created by the water velocity and depth. Discharge also varies through time, creating additional variations of hydraulic conditions. Howarth, *et al*. (1996) said "the

difference is an estimate of all the nutrients removed by ecosystem processes or stored within soils and sediments, and this can be viewed as a measure both of the services provided by an ecosystem and of their limitations".

PERFORMANCES OF FLUVIAL ECOSYSTEMS

Newbold, *et al.* (2005) pointed out "streamflow in channels moves materials, including organic particles and dissolved nutrients as well as large particles of mineral substrate. Particles or nutrients can be taken up by biological and physical processes in the bed, and then subsequently released back to the flow, resulting in cycling of particles between the bed and the flow in conjunction with downstream displacement. This pattern of coupled vertical cycling and downstream transport is known as nutrient (or particle) spiralling".

Fluvial ecosystems exhibit tremendous variability in the quantity, timing, and temporal patterns of river flow, and this profoundly influences their physical, chemical, and biological condition. Vast quantities of fresh water are extracted to meet agricultural, municipal, and industrial demands, yet freshwater ecosystems also need enough water, of sufficient quality and at the right time, to remain ecologically intact and provide economically valuable commodities and services to society. The hydrologic cycle describes the continuous cycling of water from atmosphere to earth and oceans, and back to the atmosphere. Evaporation from the oceans exceeds that over land, while precipitation on the earth's land surfaces exceeds evaporation and plant water loss becoming to the primarily river discharge and/or groundwater as well. Runoff travels by a number of pathways that are influenced by gradient, vegetation cover, soil properties, and antecedent moisture conditions. Surface and shallow subsurface flows reach streams much more quickly than water that percolates to the water table and discharges into the stream as groundwater. Thus the stream hydrograph with the rise and fall of streamflow over time exhibits a strong or a more gradual response to a rain event depending on soils, slopes, and human actions that affect flow paths.

The characterization of streamflow has practical application for the design of flood-control structures, evaluation of channel stability, and in determining whether sufficient water is available at the appropriate time to meet the needs of both people and the ecosystem. Flow analyses tell us that each individual river has a natural flow regime characterized by the magnitude of flows and their frequencies, as well as duration, timing, and rate of change. Climate, vegetation, geology, and terrain place broad constraints on natural flow regime to maintain their ecological integrity and conditions at the catchment scale make each river to some degree unique, and a wide range of human influences further alter flow regimes by changing flow pathways and response times, and even by altering climate.

TWO IMPORTANT COMPONENTS OF FLUVIAL ECOSYSTEMS

As mentioned above, flow influences the geometries of channels, the flow boundaries, inversely, channel geometries affect flow situations. Therefore, fluvial geomorphology and flow environment are obviously significant components on fluvial ecosystems.

1. Fluvial Geomorphology

Fluvial geomorphology emphasizes the dynamic interplay between rivers and Landscapes with linkages among channel, floodplain, network, and catchment in the shaping of river channels and drainage networks and is studied by using a diversity of approaches including stratigraphic analyses, experimental studies of sediment transport in flumes, modelling of physical processes and compared with the real landforms, and sophisticated statistical approaches to gain greater understanding of the physical dynamics of river systems. It helps make sense of the enormous variety exhibited among fluvial systems, and thus the habitat and environmental conditions experienced by the biota.

Quantification of the relationships among river features and analysis of the underlying processes contribute to a deeper understanding of how rivers respond to human-induced changes in water and sediment supply that can cause rivers to change their shapes. The development of stream channels and entire drainage networks, and the existence of various regular patterns in the shape of channels in dynamic equilibrium between erosion and deposition by common hydraulic processes. As depth of flow increases, near-bed velocity also increases, and streams can mobilize and transport the coarse sediment stored in the bed and banks. Nearly all gravel channels are mantled by an armor layer containing particles larger than the underlying sediment. The larger particles in the armor layer partly shield the finer particles from being dislodged by the flow, but are themselves more vulnerable to entrainment because they protrude into the high-velocity flow. As a result, large and small particles in the armor layer have nearly equal mobility, and so become entrained at nearly equal discharges (Andrews, 1983).

Stream power, the product of discharge and slope, describes the ability of the stream to mobilize and transport material. Sediment transport is directly related to stream power and inversely related to median grain size, and this is a useful relationship for understanding how a stream might respond to changes in sediment and water supply along its length, or due to human interference (see figure 1). The quantity of transported sediment increases with velocity and discharge. The dominant or effective discharge is that at which sediment transport is greatest, and it often is approximately the bankfull flood. Human activities can increase or reduce sediment yields.

Some consequences include coastal retreat, subsidence of river deltas, and loss of coastal wetland habitat. Finally, to ecologists, geomorphology provides insight into the channel features, habitat units, surface and subsurface zones, floodplains, and riparian corridors that form a complex, shifting mosaic and within which the diversity of the physical template provides the setting in biologically diverse communities flourish.

Integrated unit. QsD50 with QwS

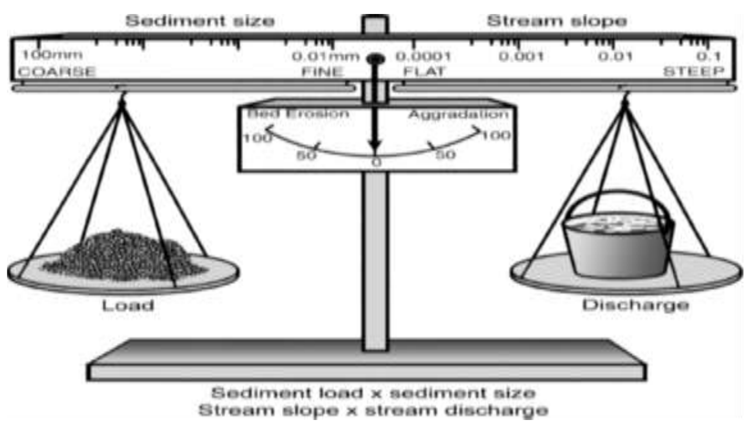

Figure 1. Lane's Law states that sediment transport is proportional to stream power (streamflow slope) and inversely proportional to sediment size. Thus stream channels are in equilibrium when: sediment discharge (Qs)* sediment particle size (D50) streamflow (Qw)* stream slope (S). (Reproduced from Brierley and Fryirs, 2005)

2. The Flow Environment

In fluvial systems the flow of water is a dominant. And characterizing variable that influences diverse aspects of the stream environment. Flow strongly influences the physical structure and hydraulic, such as channel shape, forces operating in the benthic and near-bed microhabitats, substrate composition, occupied by much of the biota, and is important to ecological interactions, rates of energy transfer, and material cycling. Current velocity, varying enormously not only along a river's length with the rise and fall of the hydrograph but also from place to place within stream channels at meso- and microhabitat owing to bed friction, topography, and bed roughness due to large substrate particles and wood, is a direct physical force that organisms experience within the water column as well as at the substrate surface. The vertical velocity profile is of fundamental importance to any consideration of the effects of current on organisms. Characterizing near-bed flows creates an enormous measurement challenge and has led to a number of imaginative attempts to estimate or directly measure flow micro environments. Surface roughness can be measured directly from particle dimensions, or by using a bed profiler such as a level plate. Mean velocity,

depth, and surface roughness are simple hydraulic variables that provide useful information about the flow environment (see figure 2)
Using open-channel measurements and certain constants one can estimate hydraulic variables including channel Reynolds number (*Re*) and Froude's number (*Fr*).
Re quantifies the ratio of inertial forces of the moving fluid to the viscous properties of a fluid that resist mixing. It is a dimensionless number that can be used to distinguish types of flow and the forces experienced by an organism while *Fr* is a dimensionless velocity to depth ratio, and differentiates tranquil flow from broken and turbulent flow. Low values of Fr are characteristic of pool habitats and higher values of riffle habitats.
Using an estimate of shear velocity (u*), which can be derived from the velocity profile near the streambed, and substituting the height of roughness elements for water depth, one can estimate roughness (boundary) Reynolds number (Re*). This variable and the dimensionless shear stress, which is related to the square of shear velocity and inversely related to particle size, describe the conditions under which particle movement is likely. Both near-bed velocity and bed shear stress increase with increasing relative roughness and mean velocity.
Abiotic factors include all physical and chemical variables that influence the distribution and abundance of organisms. Current, substrate, and temperature often are the most important variables in fluvial environments, and all organisms show adaptations that limit them to a subset of conditions.

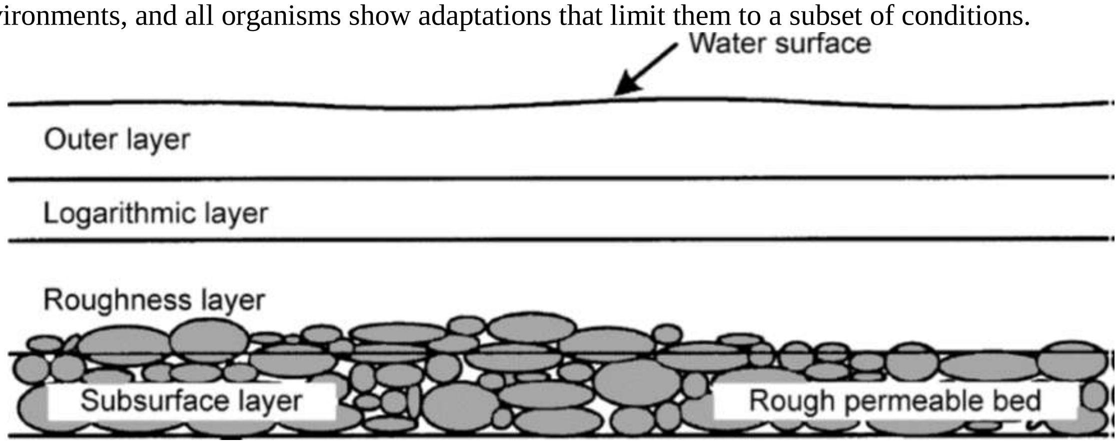

Figure 2: Subdivision of hydraulically rough open-channel flow into horizontal layers. Flow velocities within the "roughness layer'' are unpredictable based solely on knowledge of flow in the logarithmic layer. This figure is not drawn to scale.

Current and related hydraulic forces affect diverse aspects of the stream environment including channel shape and substrate, a complex physical variable including inorganic and organic composition, the physical structure and hydraulic forces operating in the benthic and near-bed microhabitats to balance between physical drag processes and the benefits due to the delivery of food, nutrients, and gasses and the removal of wastes.
Stream temperature is a key environmental variable on seasonal and daily timescales and among locations due to climate, determining the metabolic rates of organisms, their distributions, and quite possibly their success in interacting with other species and the relative importance of groundwater inputs. The extreme sensitivity of cold-water fishes to micro patch differences in temperature is evident in their ability to at least temporarily reside in cool- and warm-water systems.
Habitat preference is represented by the habitat suitability curves (see figure 3). Peaks of the suitability curves, which represent the places with the highest occurrence of a given species at a certain depth and velocity, were compared. These values are referred to as the velocity parameter—*Pv* and the depth parameter—*Pd, Pv* and *Pa* values were derived from the set of suitability curves (Zuzana Štefunková *et al.*,

2020).

The weighted usable area (*WUA*). It expresses a change in habitat quality relative to a variable parameter, usually a flow rate or a change in a channel's morphology. The *WUA* image along the flow length had a mosaic shape composed of cells. *WUA* expresses the functional relationship between the flow and the unit area of the microhabitat for the habitat. The partially weighted usable area was then determined separately by multiplication of the cell surface (*Sb*) and the combined suitability factor (*CSF*):

WUA = Sb *CSF (1)

CSF = f (Pv, Pd, Pa) (2)

Where Pa is a parameter for habitat supplementary attributes (shelter and bottom substrate). The weighting factor for *Pv, Pd, Pa* need to be evaluated, respectively.

Figure 3. Suitability curves for (a) water depth and (b) flow velocity on the mountain streams of Slovakia. Natural streams (*N*) are represented by solid lines, and regulated streams (*R*) are indicated by dashed lines.

From the simple formula, such as Manning's formula, for setting the suitability, we may have the two values, minimum and maximum, each for velocity, water depth, bed slope, and channel width, and totally we have 16 situations of combination for calculating the corresponding suitable discharges. After we look back to the long-term mean data records of discharge, QF the optimum discharge chosen for design will be defined with the corresponding velocity, water depth, channel width and bed slop, to form the necessary flow environment for the given, or said chosen, habitat life need. Finally, the WUA can be obtained from Equations (1) and (2).

Kidoo Park *et al.*, (2018) presented "habitat simulation transforms information regarding channel structure, modeled water surface levels, and velocities into an index containing the quantity of the available habitat using the Habitat Suitability Criteria (HSC)". This index is referred to as the Weighted Usable Area (WUA), which is the arithmetic sum of the available habitat in each cell for a given discharge and target species and in order to have the minimum flow rate required in a stream to preserve its function, they illustrated the flow chart which consists of four steps: (1) Calculating the drought flow by the flow-duration curve using the results of a surface runoff simulation. (2) Computing the low-flow

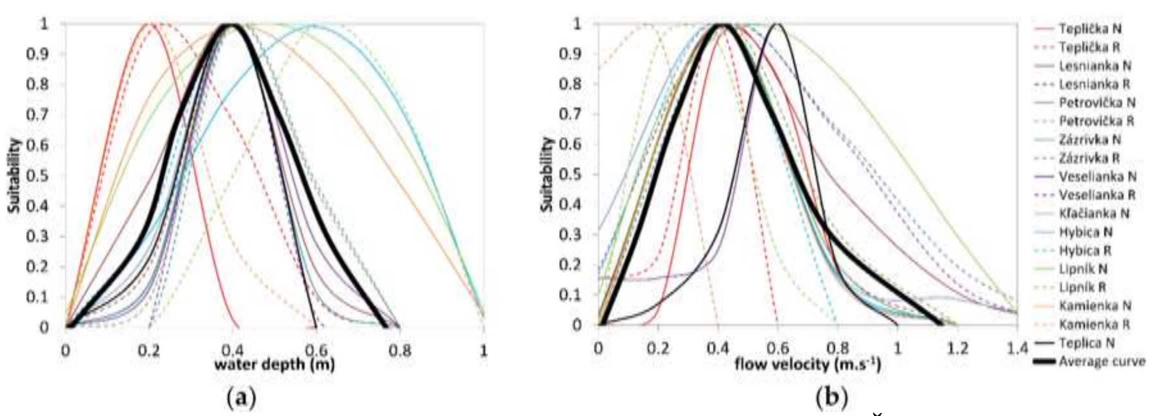

Figure 3. Suitability curve is shown by a thick, black line—adapted from Štefunková *et al.*, 2018)

with a hydrologically and biologically based design flow method using Design FLOWs (DFLOW) Version 4.1 (US Environmental Protection Agency, Washington, DC, USA. 1990) and assessing the adequacy of drought flow by comparing the low-flow (if the water shortage is very great, the structural measures of IWM should be considered selectively). (3) Determining the fish flow to herald the ecological stream restoration and obtaining the instream flow by finding the maximum flow through evaluation of the fish flow and the drought flow. (4) Suggesting an instream structure to improve fish habitats under the condition of an aquatic ecosystem where the difference (i.e., the flow rate shortage of instream flow) between fish flow and drought flow is lacking. As the ecological habitat of fish is a very important element of ecological restoration, we chose fish flow as an ecological flow. Therefore, the instream flow was determined as the maximum value between drought flow and fish flow depending on seasonal variation at a particular reach of stream. The evaluation of instream flow is given in Equation (3):

$$QIN = \max(QF, QD) \tag{3}$$

where *QIN* is the instream flow, *QF* is the habitat (fish) flow, and *QD* is the drought flow.

IMPACTS—THE SOURCES OF UNCERTAINTIES

Rivers provide numerous benefits to humankind, some of them irreplaceable. These ecosystem services include water supply for domestic, industrial, and agricultural uses, harvestable organisms, hydropower, waste disposal, navigation, recreational enjoyment, and spiritual fulfillment. Impaired lotic ecosystems may fail to provide these services, and instead of contributing to human well-being become the source of water-borne diseases including diarrhea, river blindness, schistosomiasis, and malaria. The great utility of rivers results in conflicts between types of uses, especially between those uses for which an economic value can easily be assigned, and other uses that have historically been excluded from any explicit valuation.

Causes of the imperilment of river ecosystems and their biota are diverse, and are under the headings of habitat alteration, invasive species, pollution, overexploitation, and climate change. Ultimate causes can be found in the conflicting demands on fresh water, changing land use, and the many unsustainable practices that characterize growing populations and expanding economies throughout the world. Alteration of physical habitat is the most significant threat to biodiversity and ecosystem function in the majority of human-impacted river systems by altering flows with changing hydrology with dam construction, channels straightened, widened, realigned, and stabilized for flow conveyance, and land use including all aspects of forest harvest, agricultural intensification, and the spread of urban areas. These modified patterns rarely duplicate those naturally found at streams flowing from lakes (Richardson and Macka, 1991). This interruption of the longitudinal connections along the fluvial network is referred to as “serial discontinuity.” which resulting in the interception of sediment and organic materials transported from upstream, alteration of flow and temperature regimes, changes in water chemistry, and suspended particulates.

The land, must be the major factor for the influence of on migrating fish. Alteration of physical habitat is likely the single most significant threat, and is due to many different human activities that affect flows, channel morphology, and land use.

Declines in water quality result from contaminants that reach surface waters at specific locations, which is often true of industrial and municipal wastes, or from diffuse sources, as runoff from agricultural and urban land or atmospheric deposition. Harmful water quality conditions are widespread in developed countries with nutrients and sediments from agriculture affect many streams and rivers and toxic contaminants.

Cultural preferences largely shape restoration goals. Building a culturally preferred form (such as a stable, meandering channel) is perfectly reasonable as a restoration goal. To the degree that cultural preferences remain unacknowledged, they introduce greater uncertainty in the trajectory of restoration projects. Cultural preference for tidy landscapes over messy landscapes should be acknowledged, so that ‘overgrown’ riparian zones can either be ‘framed’ or simply avoided in urban areas. Uncertainty in river restoration and environmental management has been pointed out. The arguments and evidence presented challenge the view of scientific deterministic certainty and societal beliefs that certainty is necessary in restoration. A typology for discriminating uncertainty was reviewed that can be used to separate uncertainties that can lead to unforeseen and undesirable consequences from uncertainties that lead to potentially welcome surprises. Where there are significant uncertainties on social and cultural aspects, these should probably be settled before proceeding to settle technical uncertainties.

STRATEGIES—THE CONCEPTUAL MANAGEMENT

1. Management of Spatial Framework

Fluvial networks are both heterogeneous and hierarchical has been freshly infused by collaborations between ecologists and geomorphologists. Ecologists engaged in the study of running waters have developed a number of conceptual models whose purpose is to synthesize empirical information that describes structure, function, and processes of lotic ecosystems over their enormous range of natural variations. Such models are of great value in organizing what might otherwise be a collection of seemingly unique case studies into a broader understanding based on unifying principles and predict outcomes in new settings and explain differences observed among differing discharge or occurring in different landscape and climatic settings.

Forests, or said the lands of upstream, can affect water quality in many ways. Riparian forests provide shade, which moderates water temperatures, and provide a source of organic debris and nutrients, which are used by aquatic organisms. Harr and Fredriksen (1988) suggested “natural processes in forested areas, such as landslides, channel erosion, blowdown, and wildfire, can affect water quality by creating temporarily increased concentrations of sediment, increased stream temperatures, and (or) increased nutrient concentrations”.

Forest management can affect channel morphology by changing the amount of sediment or water contributed to the streams, thus disrupting the balance of sediment input and removal. Excessive input of coarse sediments from landslides can smooth the channel gradient by filling pools. Removing large woody debris from channels reduces sediment storage and eliminates the local hydraulic variability associated with the obstruction. Loss of habitat diversity by either mechanism may reduce or change the fish species found in a stream reach. If the changes result in decreased space, populations may also decrease. Strategies to minimize the effects of land management on channel morphology and fish habitat should include practices that minimize increases in coarse sediment input, and that preserve the morphologic complexity of the channel.

To a full understanding of lotic ecosystem structure and function, in addition, landscape constraints on the physical structure of a stream ecosystem, most strongly influenced by upstream processes and by interruptions due to lakes and dams on both lateral and vertical connectivity, will determine which processes have local preeminence.

2. Determination of Community Assembly by the Species Pool, Habitat Sorting, and Species Interactions

The view that the biological assemblages of streams are made up simply of those species able to reach a particular location and survive in the habitats that it affords while in other way, the view that biological communities have repeatable structure that results not only from environmental factors, but also from the interactions among species, including certain key species. Which one is prefer? Community ecology is rich with concepts and models that address the central questions “what determines the compositional and relative abundance of species at a locale”. Among many debated issues, the importance of regional versus local processes and of chance establishment versus mechanistically driven community assembly continue to be of great interest. The stream environment is heterogeneous across all spatial and temporal scales. Individual habitat patches typically are distinctive in their environmental conditions including current, substrate, temperature, organic matter accumulations, biofilms, and so forth. Many species will differ in how well they are suited to particular conditions along an environmental gradient, and because multiple environmental gradients exist, species sorting along environmental gradients is likely to play a significant role in determining local abundances. Many aspects of climate, geology, and terrain contribute to regional variation in the solid and dissolved loads of rivers, and fluctuations in discharge are the primary cause of temporal variation. Fluvial environments also are subject to a considerable degree of temporal instability, particularly from hydrologic disturbance, and so patch residency by populations and assemblages must often be short. Disturbance frequency is a key process influencing assemblage structure, acting like a switch to favor one group of organisms over another, and contributing to overall diversity by preventing the displacement of vulnerable species by dominant species. Rivers are shaped by environmental factors that control essentially all aspects of the river’s physical appearance, vary from place to place, and can be organized. Climate, topography, geology, and vegetation cover are fixed environmental variables that the river cannot influence, and because climate tends to be expressed at a larger spatial scale than topography, their influence is approximately hierarchical.

Geology determines the availability of ions and the supply of sediments, topography determines slope and degree of containment, climate and soils determine vegetation and hence the availability of organic matter and extent of shade, and so on. Landscape ecology studies the interactions between spatial pattern and ecological processes in heterogeneous systems across a range of scales, emphasizing the importance of discrete patches, ecotones (the boundaries between patches), and the connectivity among patches. In general, ecological processes are scale dependent so that factors operating at larger scales influence smaller scale systems but not the converse, in accord with the hierarchical directionality of influence.

In the view point of statistics, for a defined space scale and time period, by induction, to have the characteristics corresponding, and then to verify and simulate to the expanded scope of space and time to find the validity and reliability. When we find something special or significant, we renew or update the situation to run again the processes. This procedure can enlarge the applicable scope with higher confidence.

3. The Conceptual Management on Uncertainty

Many of the uncertainties surrounding restoration motives, notions and approaches are most seriously manifested as communication uncertainties. That is, instead of being expressed simply as uncertainties due to limited knowledge, they are ignored and miscommunicated through the restoration process in a manner that prevents transparent decision making. The significance of the plethora of other uncertainties alluded to is largely situation-specific and, to date, unexplored.

Philosophical strategies for dealing with uncertainty ranging from the status quo of ignoring uncertainty to the advocated embracing uncertainty were reviewed. Traditional scientific research has focused on a narrow class of uncertainties and adopted ‘eliminate’ and ‘reduce’ uncertainty philosophies. It is argued that it is unethical to assume that uncertainty is insignificant.

These days, scientists in environmental science, natural resources, ecology, conservation biology, water resource management, and similar disciplines are often not trusted by the public and decision-makers to present policy-neutral science. Scientists advocating personal or organizational positions on ecological and environmental policy issues has become widely tolerated as acceptable professional behavior and is even encouraged by a segment of the scientific community. As a result, the scientific enterprise is collectively slipping into a morass that risks marginalizing the contribution of science to public policy. Public confidence that scientific information is technically accurate, policy relevant, and politically unbiased is central to informed resolution of policy and regulatory issues that are often contentious, divisive, and litigious.

Methods have been proposed that can be used to test the validity of conceptual models that often fall outside the area of peer review: independent review of the model; establishing simple guidelines for evaluating the uncertainty of a conceptual model based on the type of strength of evidence provided; ensuring that an appropriate percentage of the total cost of the project is committed to the development of the conceptual model; holding back some of the information and data that underpin the model, and using these data to verify the hypothetical model; and passing all of the data and information to a third party, without interpretation, so that a competing model can be developed. Ideally, modelling efforts should proceed with the closest possible coupling between their physical (hydraulic and hydrodynamic) and biological elements, and in close association with improved strategies for field monitoring, too. These reflect the principal sources of uncertainty in restoration schemes for ecological purposes and must be addressed to improve both field and modelling aspects of restoration design: data requirements, characterization, coupling, awareness, and development. While each of the above remains sources of uncertainty, they represent, too, areas of opportunity for the rapid development of research and intervention protocols.

The discussion of some of the value-laden decisions and judgments scientists and other researchers make is not a criticism. Rather, the issue is discussed because a failure to recognize the existence of the value-laden dimensions of science casts serious doubt about even the best and most thorough of scientific and technical studies used to inform decisions about river restoration.

In other words, unless the value-laden dimensions of scientific and technical studies used to derive information are disclosed, the positions of policy makers and decision makers will appear to be justified on objective or value–neutral scientific reasoning when they will be based in part on often controversial or conflicting values of scientists themselves. Therefore, the final source of uncertainty in science for river restoration lies within the intellect of the researchers themselves. "Division of labor with integration results and cooperation in different expert field with mutual respect" will be the useful solution for these conflict and uncertainty reducing.

CONCLUSION

Fluvial ecosystem, composing of inorganic material and organic life with humanities, geology, hydrology, hydraulics and ecology, and presenting in economy, social development on land utilization, diversity of culture and competition on nature resources, becomes the common interactive platform for mankind and nature with higher uncertainties from all the items mentioned above and forms a very complicated system for effective and accurate management. The integrating considerations on the influencing factors, the selection of suitable modelling in obvious direction for management, and the utilization of statistics with induction-deduction, may give us a more flexible strategy to guide the optimum management plane. We still have a long way to go and we need to be more diligent on our future work.

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