# Natural variability as a component of sustainable management of rivers

## La variabilité naturelle comme composante de la gestion durable des fleuves

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## RÉSUMÉ

Une gestion durable nécessite de respecter le principe de 'working with nature'. De ce point de vue, la compréhension du comportement morphodynamique naturel des rivières s'avère fondamentale. Le cadre physique, dont les composantes varient dans l'espace comme dans le temps, constitue le support indispensable à la constitution des habitats et à l'entretien de la biodiversité. Cependant, les stratégies de conservation et de gestion sont généralement basées sur des conditions statiques et de simples évaluations de l'état des cours d'eau. Si les influences allogènes sur les rivières ainsi que les modes d'ajustement aux modifications affectant ces paramètres sont beaucoup étudiés, les influences autogènes doivent désormais être plus largement reconnues et incorporées dans la gestion. Plusieurs exemples de mécanismes d'autogénèse relatifs à certaines caractéristiques des méandres sont ici examinés. Ils se rapportent à des intensités, des échelles de temps et des processus variables et concernent à la fois la forme et la localisation des boucles, les bancs ou encore la largeur des chenaux. Gestionnaires de rivières et écologues ont besoin d'un approfondissement de la connaissance des dynamiques naturelles afin que les stratégies permettant un entretien naturel des processus plutôt qu'une préservation non soutenable puissent être poursuivies et pour assurer l'espace nécessaire à la variabilité des fleuves.

## ABSTRACT

Sustainable management needs to follow the principle of 'working with nature' so understanding of the natural behaviour and dynamics or rivers is fundamental. The physical conditions provide the basis for habitats and biodiversity and so these also vary over time and space. Conservation and management strategies are commonly based on static conditions and single assessments of state. Allogenic influence on rivers and modes of adjustment to changed conditions are much researched but autogenic influences and sequences need to be more widely recognised and incorporated in management. Examples of the magnitude, timescales and process dynamics of various features of meandering rivers and the extent of autogenesis, are examined, including bend form and location, river channel bars and channel width. River managers and ecologists require knowledge of the natural dynamics so that strategies that allow for renewal rather than unsustainable preservation can be pursued and space is provided in the river corridor for variation in channel morphology and position.

## KEYWORDS

Autogenic behaviour, channel bars, channel morphodynamics, river erosion, river meanders.

# 1 PRINCPLES AND REQUIREMENTS

Understanding of the natural behaviour and dynamics is fundamental to sustainable management of rivers. Sustainable management needs to work with nature and this principle increasingly underlies strategies and techniques applied. The physical characteristics and their natural variation are also necessary preconditions for habitats and biodiversity yet much conservation practice is aimed at preservation. The WFD legislation in Europe is a driving force for management and rehabilitation in rivers but it tends to treat the ecology and hydromorphology as static. Recognition of timescales and magnitude of variability need to be incorporated in WFD hydromorphology assessments. For this, more evidence is needed and examples are provided here.

Recognition of both autogenic and allogenic influences on river behaviour also needs to be incorporated in management strategies. . Autogenic behaviour is still being underestimated in spite of substantial evidence of inherent patterns. Life-cycles of development of river features need to be identified and quantified for different types of river reach. Snapshots of evidence, as revealed, for example, by aerial photographs at periodic dates, may mask variability, so monitoring and assessments need to be at higher time resolution than the variations and cycles. Active rivers, with high rates of processes, are instructive for understanding inherent behaviour because they offer the opportunity of detecting whole cycles within the timescales of research activity and accurate evidence. They frequently also create the greatest perceived management problems.

# 2 EVIDENCE AND EXAMPLES

## 2.1 Dynamics of meander bends

Much research has shown the non-linearity of the relationship of erosion and migration rate of active meanders to curvature. The increase in complexity of form by development of compound meanders and multiple lobes on bends through to termination by cut-off has also been shown for many rivers (Hooke 2007). This needs to be accepted as a likely trajectory on very active, laterally mobile meanders, certainly once the accelerating phase of development is reached. This behaviour is evidenced in the large dataset compiled for the US Transportation Board (Lagasse et al. 2004). The time period of development of bends is quantified here for a range of meandering rivers. The timescales to cut-off varies with erosion rate and stream power and with conditions e.g. confinement and boundary resistance. This sequence is seen to occur largely irrespective of particular flow events though the specific timescale may be modified. These trends and sequences should be incorporated in predictions of channel movement and in allowance for future course development in meander restoration projects.

## 2.2 River channel bars

Channel bars of various types are major components of river systems and riverine habitats. Point bars are the main locus of deposition in meandering channels but may vary in degree of activity and calibre of sediment deposited, not only in relation to flood flow occurrence but inherent trends. Mid-channel bars can also be common in meandering rivers and may represent a transition to braiding. Development of these mid-channel bars is also seen to follow a particular sequence, which can be regarded as autogenic, and for which timescales of life-cycles can be quantified. Initiation of these bars is related to widening of the channel by excess bank erosion but occurrence of these bars can be highly variable spatially and temporally and not related to specific events (Hooke and Yorke, 2011). The sequence from initial, small gravel bar through to full attachment and incorporation in the floodplain involves feedback effects of vegetation on sedimentation once plants have colonised the bar. The implications for management are that an assessment of the hydromorphology at any one time should not be taken as the static condition in terms of numbers and state of bars. Ecologists need to recognise that bars may be transient.

## 2.3 Width

Likewise channel width in active meandering rivers can be highly variable both in space and time. Widening and narrowing can take place in response to sequences of events and conditions but form and migration of the bend can also influence width at any point, as well as bank erodibility. Occurrence of bank erosion is natural on rivers though often rivers are managed to prevent it. Occurrence can be beneficial to development and maintenance of a range of habitats and biodiversity.

## 3. CONCLUSION

River managers and ecologists need to recognise that rivers are naturally dynamic and that specific habitat locations cannot be preserved in static condition. If the river is allowed to develop naturally then those habitats will be renewed over time. Space must be allowed in the river corridor for the variation in channel morphology and position.

## LIST OF REFERENCES

Hooke, J.M. (2007). *Complexity, self-organisation and variation in behaviour in meandering rivers*. Geomorphology 91, 236-258.

Hooke, J.M. and Yorke, L. ( 2011). *Channel bar dynamics on multi-decadal timescales in an active meandering river*. Earth Surface Processes and Landforms 36, 1910-1928.

Lagasse, P.F., Zevenbergen, L.W., Spitz, W.J., Thorne, C.R., 2004. *Methodology for predicting channel migration*. NCHRP Web-Only Document 67 (Project 24-16). Report prepared for TRB (Transportation Research Board of the National Academies of the US) http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w67.pdf