Habitat restoration and sediment transport in rivers

Streams and rivers or any bodies of flowing water are dynamic by nature. Through erosion and deposition, streams and rivers transport and transform the surface of the earth. Society's increasingly intensive and more permanent nature of land use means that the rivers are consigned to specific areas, resulting in a restriction of their naturally dynamic behavior. The purpose of river engineering works is to bring the rivers under control so that their naturally dynamic behavior does not overly endanger the interests of society. Originally, effort was put into understanding of the physics of river processes because it was important for the design of technical river engineering control works such as navigation, flood control, power etc. The river ecology was either expected to look after itself or was not considered important or scarce enough to conserve. Now the river region is increasingly considered as a living ecosystem for which the physical, biological and ecological processes are all important.

Current Projects: *Fish habitat restoration in rivers*: In the past rivers' dynamic nature has been constrained by efforts to reduce erosion and flooding. The resulting loss of spatial and temporal heterogeneity of the river has reduced its ability to sustain a diverse ecology. Salmonids need pool and riffle habitat to support spawning and the rearing of juveniles. Flow deflectors, used as habitat improvement structures to create pools, are being studied in the field and numerically to develop design recommendations to aid in successful field implementation.
Sources, transport and fate of sediments in the St. Joseph River Catchment: Developmental pressures for urbanization and agriculture are causing sedimentation in the rivers in Trinidad and Tobago. This increasing problem is a major factor contributing to the increased frequency of flooding, increases in pollutant loadings and to the impairment of the downstream swamp habitat. The current study aims to characterize the sediment sources to enable predictions of loading and subsequently develop non-structural and structural strategies to control loadings.

Past projects: *Recirculating flow in river embayments*: The exchange of matter occurs between the main flow of a river and the dead zones at its periphery, which are due either to the naturally irregular banks or to man-made structures such as groyne fields. Two concerns arise from this exchange, the first is the rate of propagation of a pollutant cloud (or nutrients) along the river and the second is the residence time of the pollutants (or nutrients) within the environmental micro-habitats in the dead zones. A study of the flow structures and exchange processes within a square embayment adjacent to a channel indicated that the exchange occurs in a two stage process, which needs to be included in improved longitudinal dispersion models. *Erosion of cohesive sediment in the St. Lawrence River*: The St. Lawrence River lies on the structured marine clays of the Champlain Sea. Recession rates of up to 3 m/yr are observed between Montreal and Lac St. Pierre. A laboratory study on undisturbed clay samples was undertaken to determine the relative rates of erosion due to waves and a uni-directional current and the importance of desiccation.

Collaborators:
Prof. Pascale Biron, Geography, Concordia University, Canada
Dr. Vincent Cooper, Civil and Environmental Engineering, University of the West Indies, Trinidad.
Dr. Serge Lapage, Centre St. Laurent, Environment Canada

Student theses:
Current:
Baccard, Matthieu (M.Eng.): Sediment loadings in the Maracas-St.Joseph catchment, Trinidad. (Co-supervision with Vincent Cooper, Department of Civil and Environmental Engineering, University of the West Indies).

David Carré (Ph.D.): Flow dynamics and sediment transport around paired deflectors for fish habitat enhancement: a field study in the Nicolet River (Co-supervision with Pascale Biron, Geography, Concordia University).

Past:

Jaramillo, Fernando (M.Eng. 2007): Estimating and modelling soil loss and sediment yield in the Maracas-St. Joseph catchment with empirical models (RUSLE,and MUSLE) and a physically based model (EROSION 3D). (Co-supervision with Vincent Cooper, Department of Civil and Environmental Engineering, University of West Indies).

Karen Ng (M.Eng. 2006): Two dimensional hydraulic-habitat modelling of a rehabilitated river.

Elizabeth Jamieson (M.Eng. 2005): Experimental investigation of recirculating flow in an open channel embayment using three-dimensional particle tracking.

Linda Kemp (M.Eng. 2002): Photo-tagged particle tracking: An investigation of recirculating flow in an embayment.

Abdellatif Al Shafie (M.Eng. 2001): Erosion of post-glacial clay due to waves in the St. Lawrence River. (collaboration with Serge Lapage, Centre St.Laurent, Environment Canada)

Anne-Titia Bove (M.Eng. 2000): Photo-activated tracer particles -- a preliminary study.

Publications:

Carre, D., Biron, P.M. & Gaskin S.J. (2007) Flow dynamics and sediment transport around paired deflectors for fish habitat enhancement: a field study in the Nicolet River, *Canadian Journal of Civil Engineering*, **34**:761-769.

Biron, M. P., **Robson, C.**, Lapointe, M.F. & Gaskin, S.J. (2005) Three-dimensional flow dynamics around deflectors, *River Research and Applications*, **21**:961-975.

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Biron, P.M., **Robson, C.**, Lapointe, M.F.and Gaskin, S.J.(2004) Deflector designs for fish habitat restoration. *Environmental Management*, Vol. 33, 1, 25-35.

Gaskin, S.J., **Pieterse, J. AlShafie, A.** & S. Lepage (2003) Erosion of undisturbed clay samples from the banks of the St. Lawrence River, *Canadian Journal of Civil Engineering,* **30**, pp. 585-595.

Jaramillo, F., Gaskin, S.J. and Cooper, V. (2007) Application of the Erosion 3D model to a developing catchment, *11th Diffuse Pollution Conference and 1st Meeting of Diffuse Pollution and Urban Drainage Specialist Group*s, 26 – 31 August 2007, Belo Horizonte, Brazil.pp.1-8.

Jamieson, E. & Gaskin, S.J. (2007) Laboratory study of 3 dimensional characteristics of re-circulating flow in a river embayment*, 32nd Congress of IAHR*, July 1-6 2007, Venice, Italy.pp.1-9.

Carre, D.M., Biron, P.M. & Gaskin, S.J. (2006) A three dimensional model around paired deflectors for fish habitat enhancement, Proceedings of the RiverFlow 2006 Conference, Lisbon, Portugal, Ferreira, R.M.L., Alves, E.C.T.L., Leal, J.G.A.B. and Cardosa, A.H. (Eds.), Taylor and Francis, 1889-1895.

Carre, D., Biron, P.M. & Gaskin S.J. (2005) Flow dynamics and sediment transport around paired deflectors for fish habitat enhancement, *17th Canadian Hydrotechnical Conference*, Edmonton, Alberta, Canada, August 17-19, 2005.pp.345-353. Prize for best student paper/presentation at conference.

Gaskin*, S.J.**, Kemp, L.** & Nicell, J. (2002) Lagrangian tracking of specified flow parcels in a shallow embayment using phosphorescent particles, *Hydraulic Measurements and Experimental Methods Conference*, CD-Rom, Session C6, pp. 1-9, EWRI & IAHR, Estes Park, Colorado, USA, July 28-Aug 1, 2002.

Gaskin*, S.J**., Pieterse, J. AlShafie, A.** & S. Lepage (2001) Erosion of post-glacial clay along the banks of the St. Lawrence River, *Proceeding of the 15th Canadian Hydrotechnical Conference*, CSCE, Volume H(19), pp. 1-7. Victoria, BC., May 30 – June 2, 2001.