H33 Computer Simulation for Drift Trajectories of Objects in the Magdalena River, Colombia

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After attending this presentation, attendees will understand the appli- cation of computer modeling in the analysis of taphonomic process (specially transport) related to bodies disposed in water systems.

This presentation will impact the forensic community by serving as an example of the use of technological tools in the investigation of forensic cases and the interdisciplinary collaboration.

Within the field of forensic science there is a growing trend towards the use of computer models to represent transport and degradation processes to which human carcasses are subject along rivers. These may also be used to predict downstream distance traveled by such bodies under likely scenarios, thus helping both the search for victims and the identification of feasible points of entry.

In studies of bodies disposed in moving waters, many problems arise since the bodies not only decompose but also are exposed to transport, disar- ticulation and dispersion. In such cases, computer modeling has proven to be an invaluable tool leading towards the understanding of former cases and the prediction of the flow pattern of bodies (Ebessmeyer and Haglund, 1994; Carniel *et al.*, 2002).

In this paper a one-dimensional hydraulic model has been coupled with an object transport model in order to predict the object drift trajectories and distance traveled with time. The object transport is modelled taking into account buoyant, hydrostatic and dynamic forces calculated using velocity, discharge and depth computed by the numerical hydraulic model. Results and information from previous research studies were incorporated into the modelling framework to represent the transport of living and dead human bodies of different densities and specific gravities (Krzywicki and Chinn, 1967; Donoghue and Minniguerode, 1977).

The model was calibrated by means of physical experiments carried out in the Teusacá and Magdalena rivers (Colombia). Objects of 21 kg and 44 kg and densities ranging from 0.98 to 1.02 g/cm^3 were placed into the rivers, and their movement and drift trajectories were monitored and regis- tered. Detailed hydraulic data during the experiments was gathered and the objects' travel times were measured. The information was used to calibrate and validate the coupled hydraulic and object transport numerical model.

Objects disposed at high flow velocity sections were observed to travel downstream with the main flow. Along bends, the objects typically followed a path close to the external river banks. In most of the cases, the objects moved after the bend with the main surface flow from the external river bank in the direction towards the opposite bank. Objects disposed at low flow velocity sections near the river bank were observed to get trapped for a long time before a circular motion forced the bodies back into the main flow. The presence of debris and snags in the river banks altered the direction and velocity of the surface flow, producing whirls and eddies where the floating body got trapped, reducing its effective longitudinal velocity. Along the 10 km long experimental stretch of the Magdalena River the actual observed ratio between the 44 kg (〉 = 0.99 g/cm^3) object velocity and the mean flow velocity was 0.91 for a flow discharge of 950 m^3/s. In turn, along the 50 m long experimental stretch of the Teusacá River the correlation between the 21 kg object (〉 = 1.02 g/cm^3) velocity and the mean flow velocity was 0.9 for a discharge of 1.97 m^3/s.

The calibrated model has been applied to a 400 km stretch of the Magdalena River – Colombia in order to simulate objects´s transport, and to predict their location after being disposed into the river at a certain time. The river model was implemented using hydrograph time series of data provided by the Institute of Hydrology and Meteorology of Colombia and hydraulic data gathered by the Hydraulic Laboratory of the National University of Colombia (1998 -2003). Travel times between 7.5 and 11 days and a loss of mass of about 4.6 kg, were computed for human bodies traveling the 400 km river stretch.

The study concludes that the density and the wetted surface area of the body are the main factors affecting the pattern of movement and traveled distance during a specific time interval along a river. Extrinsic factors related to the geometric configuration of the river and the physical and environ- mental conditions at the banks also affect the pattern of transport. In the studied Magdalena River stretch, the predicted body transport velocity is lower than the mean flow velocity by a factor ranging from 0.7 to 1.1, depending upon the presence of dead zones, and flow storage zones of recir- culating water where the body can get trapped.

Object Drift Trajectories Along Rivers, Hydraulic and Object Transport Numerical Modeling, Magdalena River

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