EVOLUTION OF TITAN'S AND EARTH'S RIVERS. K. M. Misiura[1] and L. Czechowski[2], [1] Institute of Geophysics, Warsaw University, ul. Pasteura 7, 02-093 Warszawa, Poland; kasiazlowodzka@gmail.com , Fax: +48-22-5546882, [2]Institute of Geophysics, Warsaw University, ul. Pasteura 7, 02-093 Warszawa, Poland; lczecho@op.pl .

Introduction: Titan is the only celestial body, beside the Earth, where liquid is present on the surface. Liquid forms a number of lakes and rivers. Through the work of the probe Cassini-Huygens, we know that there are similar geological structures and processes (e.g. meandering, sediment transport, bank erosion) on the Titan as well as on the Earth. In our research we use numerical model of the river to determine differences on evolution of rivers on the Earth and on Titan.

Basic equations of our model: The dynamical analysis of the considered rivers is performed using the package CCHE modified for the specific conditions on Titan. The package is based on the Navier-Stokes equations for depth-integrated two dimensional, turbulent flow:

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -g\frac{\partial z}{\partial x} + \frac{1}{h}\left(\frac{\partial(h\tau_{xx})}{\partial x} + \frac{\partial(h\tau_{xy})}{\partial y}\right)$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -g\frac{\partial z}{\partial y} + \frac{1}{h}\left(\frac{\partial(h\tau_{yx})}{\partial x} + \frac{\partial(h\tau_{yy})}{\partial y}\right).$$

and three dimensional convection-diffusion equation of sediment transport:

$$\frac{\partial c_k}{\partial t} + \frac{\partial(uc_k)}{\partial x} + \frac{\partial(vc_k)}{\partial y} + \frac{\partial(wc_k)}{\partial z} - \frac{\partial(\omega_{sk}c_k)}{\partial z} = \frac{\partial}{\partial x}\left(\varepsilon_s\frac{\partial c_k}{\partial x}\right) + \frac{\partial}{\partial y}\left(\varepsilon_s\frac{\partial c_k}{\partial y}\right) + \frac{\partial}{\partial z}\left(\varepsilon_s\frac{\partial c_k}{\partial z}\right)$$

where u, v and w are the depth-integrated velocity components in the x, y and z directions respectively; g is the gravitational acceleration; Z is the water surface elevation; ρ is water density; h is the local water depth; τ_{xx}, τ_{xy}, τ_{yx} and τ_{yy} are the depth integrated Reynolds stresses; τ_{bx} and τ_{by} are shear stresses on the bed surface; c_k is concentration and ω_{sk} is terminal velocity of k-size sediment, ε_s is turbulent diffusivity.

Parameters of the model: A few kinds of liquid are found on Titan. The liquid that fall as a rain has different properties than the fluid forming lakes. To our calculation we use only the liquids mentioned in Table 1 and 2 (e.g. [3]).

Table 1: Composition of two considered liquid existing on Titan's surface.

	Rain	Lake liquid
Methane	75%	10%
Ethane		74%
Propane		7%
Butane		8,5%
Nitrogen	25%	0,5%

Table 2: Material properties of liquids.

	Viscosity [Pa s]	Density [kg m^{-3}]
Water	$1{,}52\times10^{-3}$	999,8
Rain	$1{,}51\times10^{-4}$	518
Methane	$2{,}08\times10^{-4}$	454
Lake liquid	$1{,}42\times10^{-3}$	658

Results: We compare results of our calculation for flow of different liquids and for sediment transport for the Earth (Figure 1) and for Titan (Figure 2). The basic statement is that on Titan the transport of sediment is more efficient than on Earth for rivers of the same geometry and total discharge.

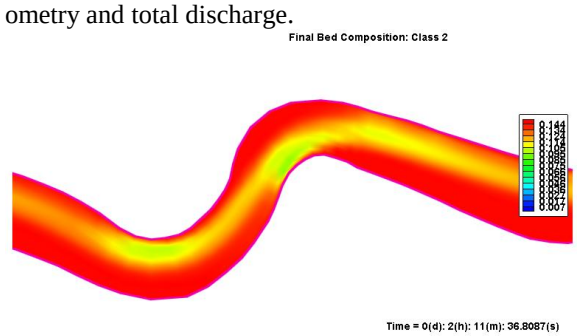

Figure 1: Results of sediment transport for terrestrial river for 3×10^{-5} m diameter.

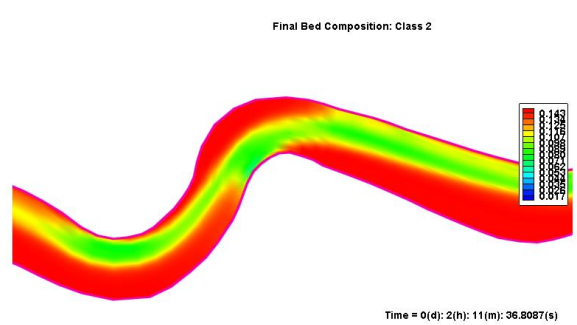

Figure 2: Results of sediment transport for Titan's river for 3×10^{-5} m diameter. Note that in Figure 1 there are only small regions where sediment was eroded (small green spots), when in Figure 2 sediment was eroded on larger region (it is well seen green line).

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