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# Comparison of sedimentary processes in rivers of Titan and the Earth – further results

K. Misiura and L. Czechowski

Institute of Geophysics, Warsaw University, Poland (kasiazlowodzka@gmail.com / Fax: +48-22-5546882)

## Abstract

Titan is a very special body in the Solar System. As the only one moon, it has a dense atmosphere and liquid on its surface. 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 the present paper we compare these processes on the Earth and on Titan.

## 1. Introduction

Titan is the only celestial body, beside the Earth, where liquid is present on the surface. The liquid is composed mostly of light hydrocarbons. It forms a number of lakes and rivers. However sedimentary processes depend on many parameter, e.g. gravity, fluid viscosity and density, density of solid material etc. Therefore processes on Titan could evolve in different way and rate than similar processes on the Earth. We use numerical model to determine differences in evolution of rivers on the Earth and on Titan. The dynamical analysis of rivers is performed using the numerical package modified for specific conditions on Titan. The model is based on the Navier-Stokes equations for depth-integrated two dimensional, turbulent flow and on three dimensional convection-diffusion equation of sediment transport ([1], [2] and [3]). We use data about terrestrial rives as well as about the rivers observed by Cassini in the vicinity of the Huygens landing site (Figure 1) and some other regions of Titan.

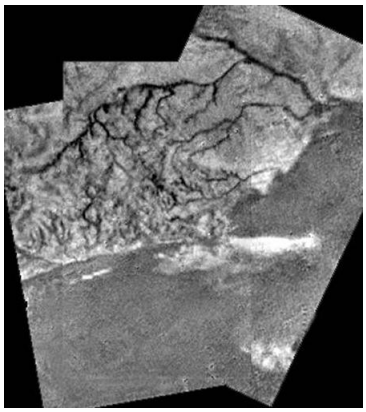

Figure 1: Photo made by Huygens probe during descend. We can see the main river and its tributaries.

## 2. Results

The results of some of our calculation of sediment transport are seen on Figure 2. The first conclusion is that on Titan the transport of sediment is more efficient than on the Earth and the main way of transport on Titan is suspended load [4]. Another statements is that different combination of initial conditions of suspended and bedload for the Earth and Titan is able to reconstruct sedimentation of meandering rivers. Also simulations of flow show many interesting conclusions as relationship between initial total discharge and gravity acceleration. This simulation was performed for water (for the Earth) and for liquid corresponding to rain for Titan.

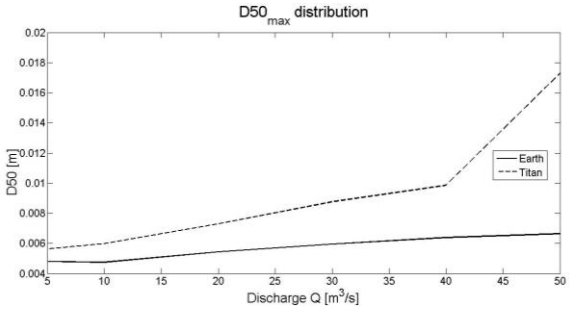

Figure 2: Maximal values of median of particle size distribution $D50_{max}$ versus discharge $Q$ [$m^3s^{-1}$]. Boundary condition: the level of the liquid on the outflow is 7 m. Note that $D50_{max}$ characterizes hole river channel.

# 3. 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. [5]).

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 $m^{-3}$] | Heat capacity [J $kg^{-1}$ $K^{-1}$] | Thermal expansivity [$K^{-1}$] |
|---|---|---|---|---|
| Water | $1{,}52\times10^{-3}$ | 999,8 | 4187 | $2{,}07\times10^{-4}$ |
| Rain | $1{,}51\times10^{-4}$ | 518 | 3250 | $1{,}14\times10^{-3}$ |
| Methane | $2{,}08\times10^{-4}$ | 454 | 3290 | $3{,}54\times10^{-3}$ |
| Lake liquid | $1{,}42\times10^{-3}$ | 658 | 2400 | $1{,}61\times10^{-3}$ |

# 4. Laboratory model

We are developing the laboratory facilities for modeling extraterrestrial rivers. Although the size and discharge of the model are negligible comparing to real rivers, the experimental results are of great importance. They could be used for testing methods of scaling as well as the results of numerical models.

# 5. Conclusions

The results of our simulation show the differences in behaviour of the flow and of sedimentation on Titan and on the Earth. Our preliminary results indicate that transport of material by Titan's rivers is more efficient than by terrestrial rivers for the same geometry parameters and initial conditions, and the main way of transport on Titan is suspended load.

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# References

[1] Duan, J., Julien, P.: Numerical simulation of the inception of channel meandering, Earth Surface Processes and Landforms, Vol. 30, pp. 1093 – 1110, 2005.

[2] Duan, J., Julien, P.: Numerical simulation of meandering evolution, Journal of Hydrology, Vol. 391, pp. 34 – 46, 2010.

[3] Jia Y., Wang S., "CCHE2D: Two-dimensional Hydrodynamic and Sediment Transport Model For Unsteady Open Channel Flow Over Loose Bed", Technical Report No. NCCHE-TR-2001-1, 2001

[4] Misiura, K., Czechowski, L., 2013. Comparison of sedimentary processes in rivers of Titan and the Earth. EPSC Abstracts Vol. 8, EPSC2013-554.

[5] Czechowski, L., Kossacki, K.: Thermal convection in the porous methane-soaked regolith in Titan: Finite amplitude convection, Icarus, Vol. 217, pp.130 – 143, 2012.