Water Day Conference

MORPHODYNAMIC STUDY OF A RIVER TO ATTENUATE FLOOD WAVES, CASE STUDY OF NYABUGOGO RIVER

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Presentation Outline

1. Introduction/Background
2. Study Area
3. Research Objectives
4. Methodology
5. Results and Discussion
6. Conclusion

Background

- Nowadays the Nyabugogo River **is being flooded due to the interaction between human activity and urbanization** observed through covering the land with impermeable surfaces which decreases the infiltration rate of the rain water**;**
- This **increases the danger** of sudden flooding of rivers in catchments.

Background

The **effects of these floods** in Nyabugogo area, **can be classified** as follows:

(1) **Primary effects**: Physical damage which can damage any type of structure including bridges, cars, buildings, sewerage systems, roadways and canals,

(2) **Secondary effects**: Water supplies, diseases, crops and flood supplies, vegetation and transport;

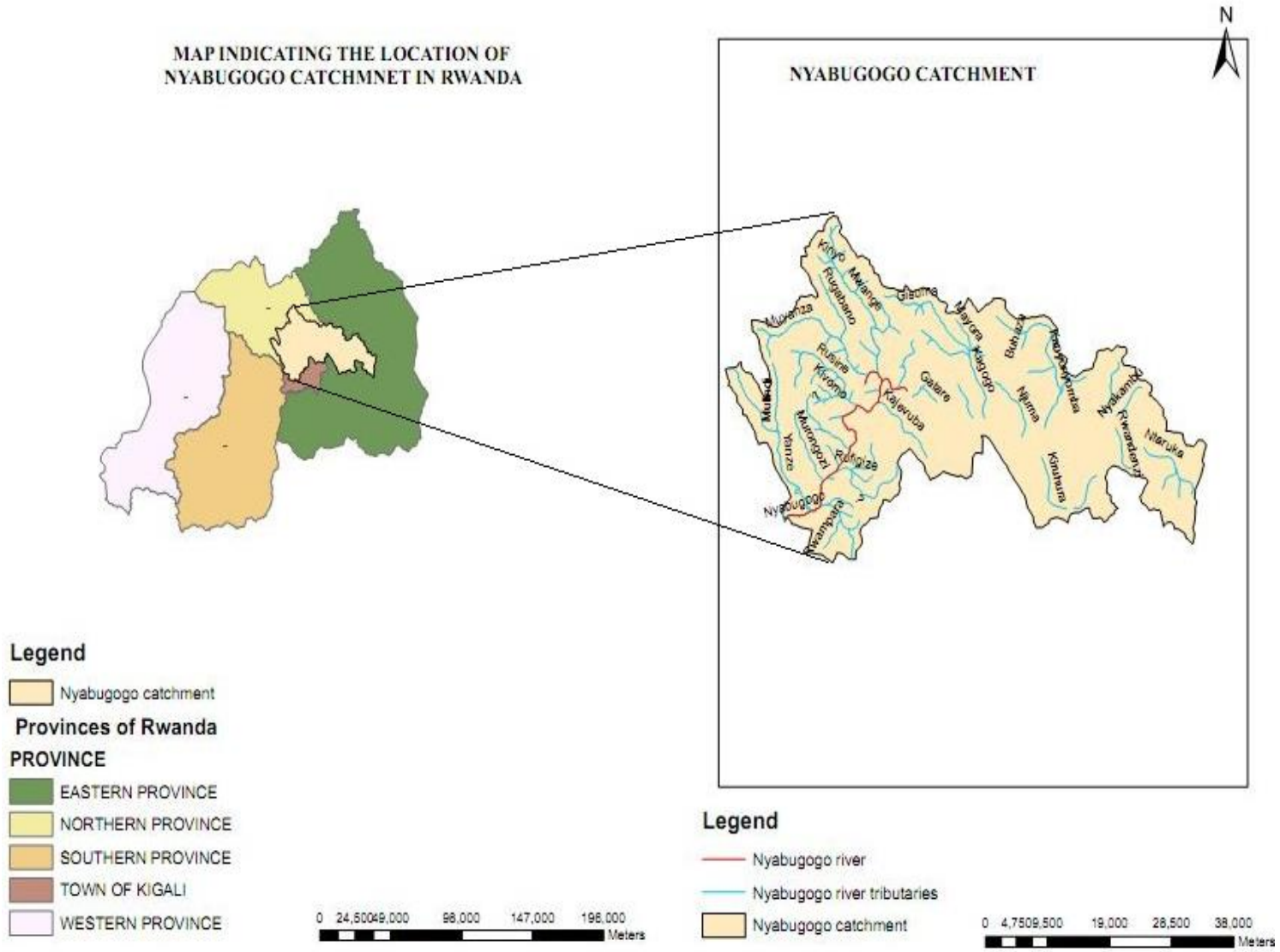
(3) **Tertiary and long-term effects**: Economic

Example of recent flood case

- The recent floods occurred in **Feb 2013** affected Nyabugogo wetland and **caused loss of properties, loss of 4 human lives** through a car which was drawn by the water, and
- **Disruption of socio-economic activities**, disruption of the business in the area and other issues related to transport facilities that at times became stand still

Loss of 4 human lives through this car

Study Area



Location of Nyabugogo catchment in the Rwanda Administrative map

- Total **area of 1,647 km^2**
- Nyabugogo river, total **length of 42.7 km**
- Main **Inflow** is lake Muhazi

Study Area

Location of Nyabugogo flooded area.

Objectives of the study

- To assess **different hydrological parameters** that contribute to the Nyabugogo river flooding; and
- Evaluate whether geometric alteration would allow for a **deduction in flood waves**.

Methodology

- **Different approaches were used:**

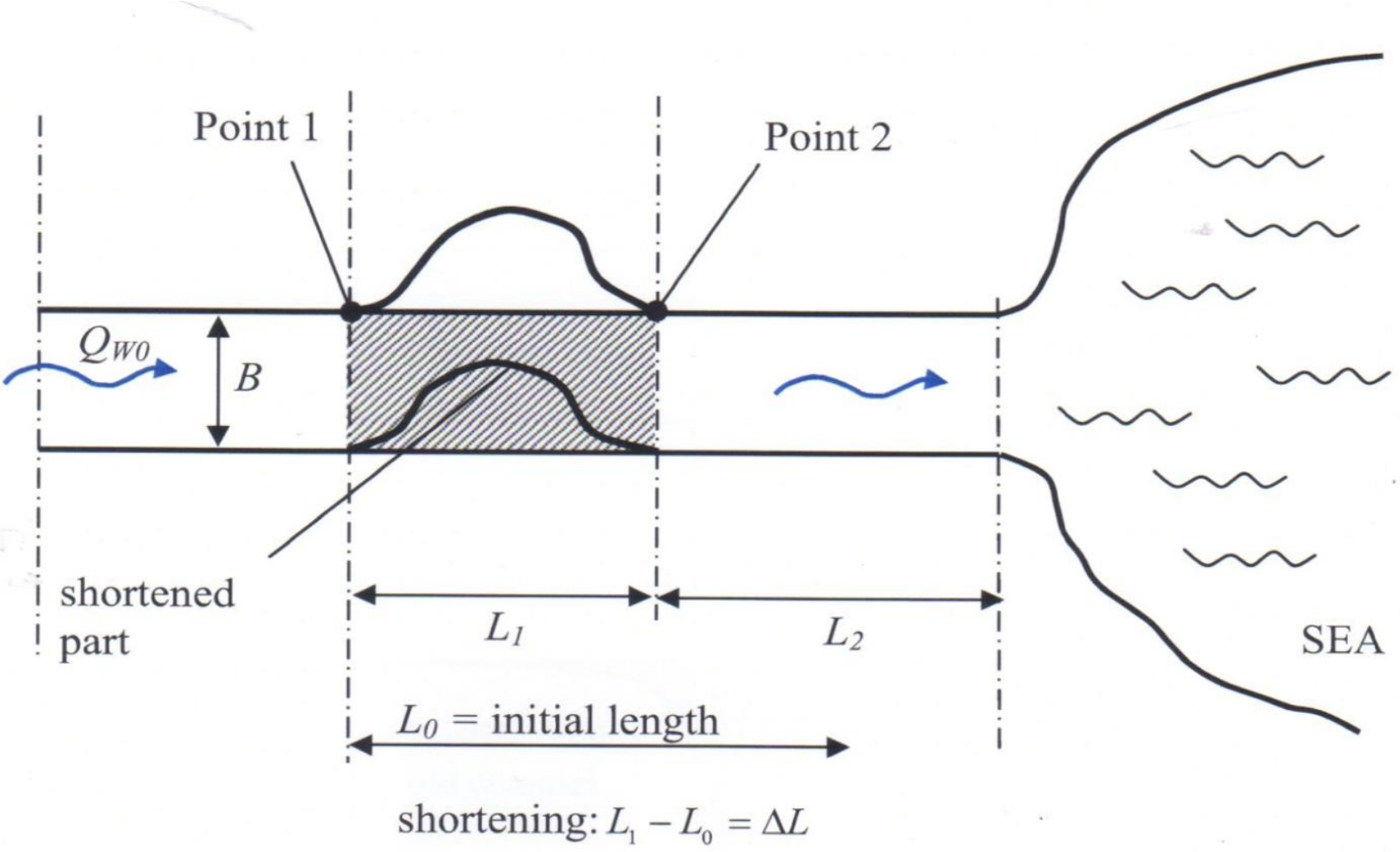
➢ Firstly the **analysis of hydro-meteorological data** collected nearby the Nyabugogo catchment in 2011 and

➢ **ArcGIS approaches** to delineate, calculate the area, slope of the catchment and the length of the river.

➢ Thereafter, **statistical and hydrological analyses** of the existing and acquired data were done by the use of **Unit hydrograph method** and **computer program** like MS Excel and ArcMap.

➢ The **Exner principle** was applied to analyze the law of mass conservation for sediment, also named "**sediment balance**".

Exner principle



Top view of a shortened reach. L_0 is the initial length of the meandering reach and L_1 the final length, with $l_1<L_0$. Shortening is L_0-L_1 (Crosato, 2010).

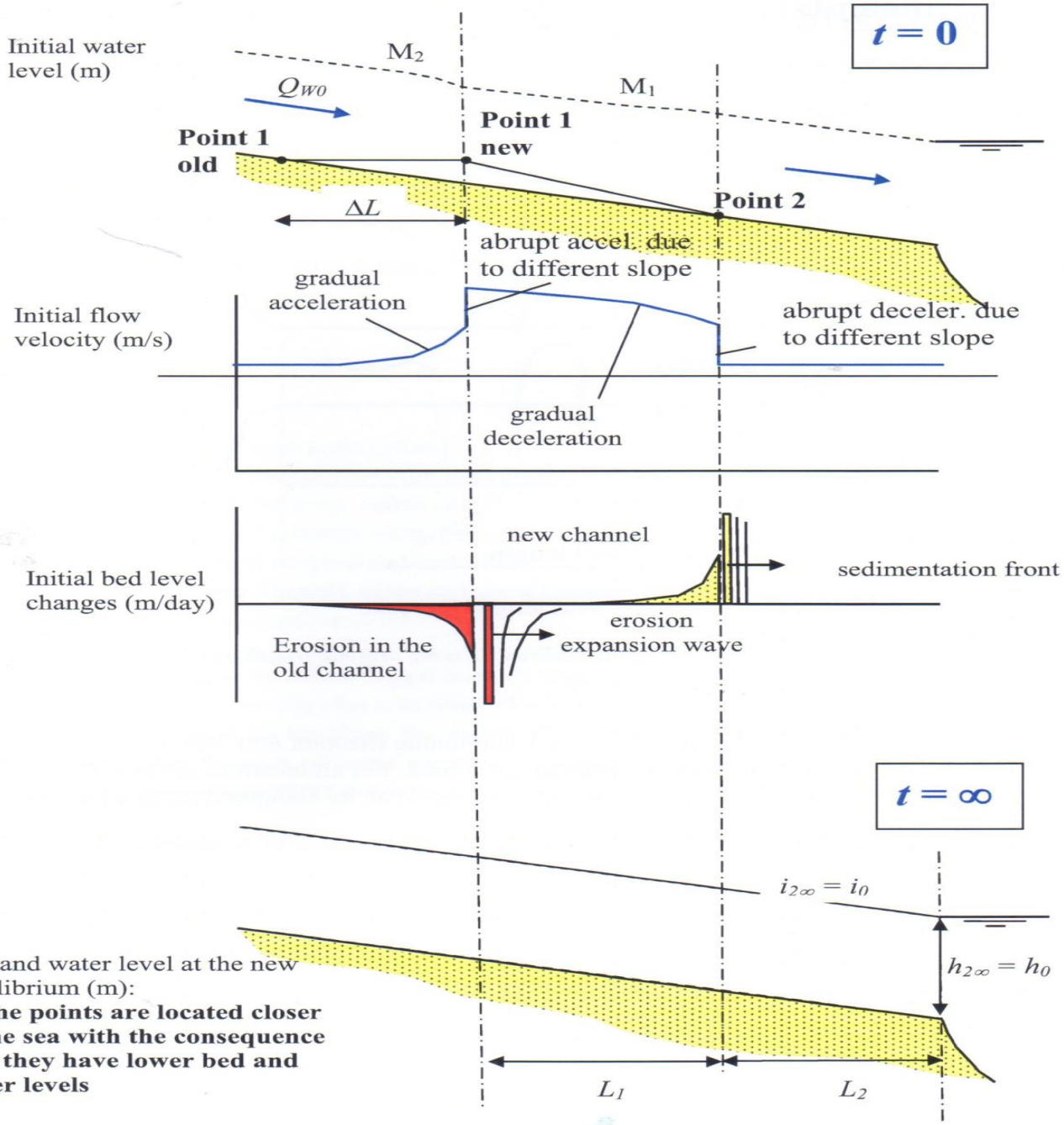
Exner principle (cont')

$$\Delta z_b(L,\infty) = \Delta L i_0 \qquad \Delta z_w(L,\infty) = \Delta z_b(L,\infty) = \Delta L i_0$$

Where Δz_w and Δz_b are the changes of water level and river bed, respectively.

For the **shortened reach** the **comparison** between final and initial configuration **depends** on the **specific situation**.

The **width is equal** to the one of the original channel and the **water depth is equal to** the normal water depth.



Bed and water level at the new equilibrium (m):
all the points are located closer to the sea with the consequence that they have lower bed and water levels

Results and discussion

The location of Nyabugogo river reach to shorten.

Results and Discussion

Short and long term responses

- The short-term and long term responses to the shortening of a river are illustrated in above figure, **assuming that sediment transport** formula and **Chézy coefficient** are the same in all situations.
- Initially, the **shortened reach has** higher longitudinal bed slope, higher velocity and smaller water depth.
- The **shortened reach has** higher sediment transport capacity than the old channel.

Short and long term responses(cont')

- **Erosion takes place** near the upstream end of the shortened reach (point 1) and sedimentation near the downstream end (point 2).
- **Erosion and sedimentation** also progress upstream until the river channel has reached the same slope and water mouth (distances computed along the river axis).
- The **result is the lowering of the bed** and **water levels upstream of point 2**.

Conclusion

- Flooding occurred in Nyabugogo river and in its surrounding areas during rainy season **are caused mainly by meanders** at some Nyabugogo river reaches.
- These floods are **not flash floods** because they like to occur every year and for a long event.
- It is to say, response to flood hazards that can be undertaken in two ways; **engineering approach**, to control flooding such as elimination of meanders by a straight reaches of the river.
- And **Non-engineering approach or regulatory approach** like **forestation** of side hills where the agriculture is no longer practiced as well as **creation of buffer zone** along the Nyabugogo river channel and **Rainwater harvesting system,** should be designed to decrease vulnerability to flooding.

THANK YOU FOR YOUR KIND ATTENTION