Geoscape Ottawa-Gatineau

Grade 9 - 11 Lesson Plans to accompany the Geoscape Ottawa-Gatineau poster and website

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Theme 9 : LANDSLIDES : THE EARTH CAN MOVE

OVERVIEW

- Students appreciate the extent of the hazard and the elements of risk associated with local landslides
- Students identify and describe the forces that determine "Mass Wasting" especially focusing on those landslides prevalent in the Ottawa-Gatineau area, – earthflows in sensitive marine (Leda) clay
- Students complete an exercise to assess the hazard along the South Nation River
- Students determine what geological engineering studies need to be completed to assess regional slope instability

DURATION 120 minutes (2 periods)

ACTIVITY

1. The teacher directs the class in an introduction to the factors that determine mass wasting in a variety of landscapes. Students take notes.
    - It is important that the teacher emphasize the unique geological conditions that occurred in the Ottawa-St. Lawrence valleys (rapid deposition in a temporary sea (Champlain Sea) at the edge of an ice sheet) and that most landslides in this region occur in the sensitive marine (Leda) clay of this sea. These landslides are influenced less by gravity and more by the unstable particle structure and high moisture content of the clay. This material may liquefy and flow, driven by its own weight, and rapidly destroy large areas of flat land and flow out for great distances. This type of landslide is called an earthflow.
    - Teacher may use the accompanying Failure Sequence diagram to explain these landslides.
    - Two 15-second videos recording an actual rapid earthflow (Rissa) can be seen on the website of the Norwegian Geotechnical Institute http://www.ngi.no/English/default.asp?action=showarticle&artid=6AF823C033724E43A7DA8646C5EF13ED .

2. In small groups students design and exhibit one demonstration to show the following relationships :
    A. the effect of the angle of slope on mass wasting
    B. the effect of saturation by water on mass wasting
    C. the effect of the nature and particle size of the material on mass wasting. Materials to include clay, silt, fine sand, coarse sand, pebbles, cobbles.
    D. the effect of a combination of any of the factors in A, B, and/or C on mass wasting

    Students summarize their conclusions from the demonstrations presented.

3. Using the Geoscape poster or website, students identify the properties of sensitive marine clay (Leda clay) that make it very susceptible to slope instability.

4. Large earthflows are most likely to occur where rivers have deeply eroded into marine clay, resulting in high, steep banks in sensitive material. Students map the location of potential landslide areas on a blank outline map of the Ottawa-Gatineau Geoscape using topographic maps (for steep slopes and rivers) and surficial geology maps (GSC Map 1506A or 1425A, or the Urban Geology of the National Capital Area website at http://gsc.nrcan.gc.ca/urbgeo/natcap/surf_introduction_e.php. (Choose <Maps - GeoServ>)), as well as the Canada Landslides website http://gsc.nrcan.gc.ca/landslides/clp/.

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5. Students locate and label on their maps the actual landslides found on the GSC Surficial Geology Maps. Add to legend. (Note: some areas from the previous activity may overlap, so select appropriate colours to allow for the coinciding.) Students locate Notre-Dame-de-la-Salette, Lemieux and the South Nation River on their maps and summarize the events that took place there (See Geoscape poster or landslides website). Currently the South Nation area is the most active area of landsliding in the Geoscape. Students indicate on their map which segment of the river is most likely to experience large landslides in the future and explain the basis of their decision.

6. In class discussion, students:

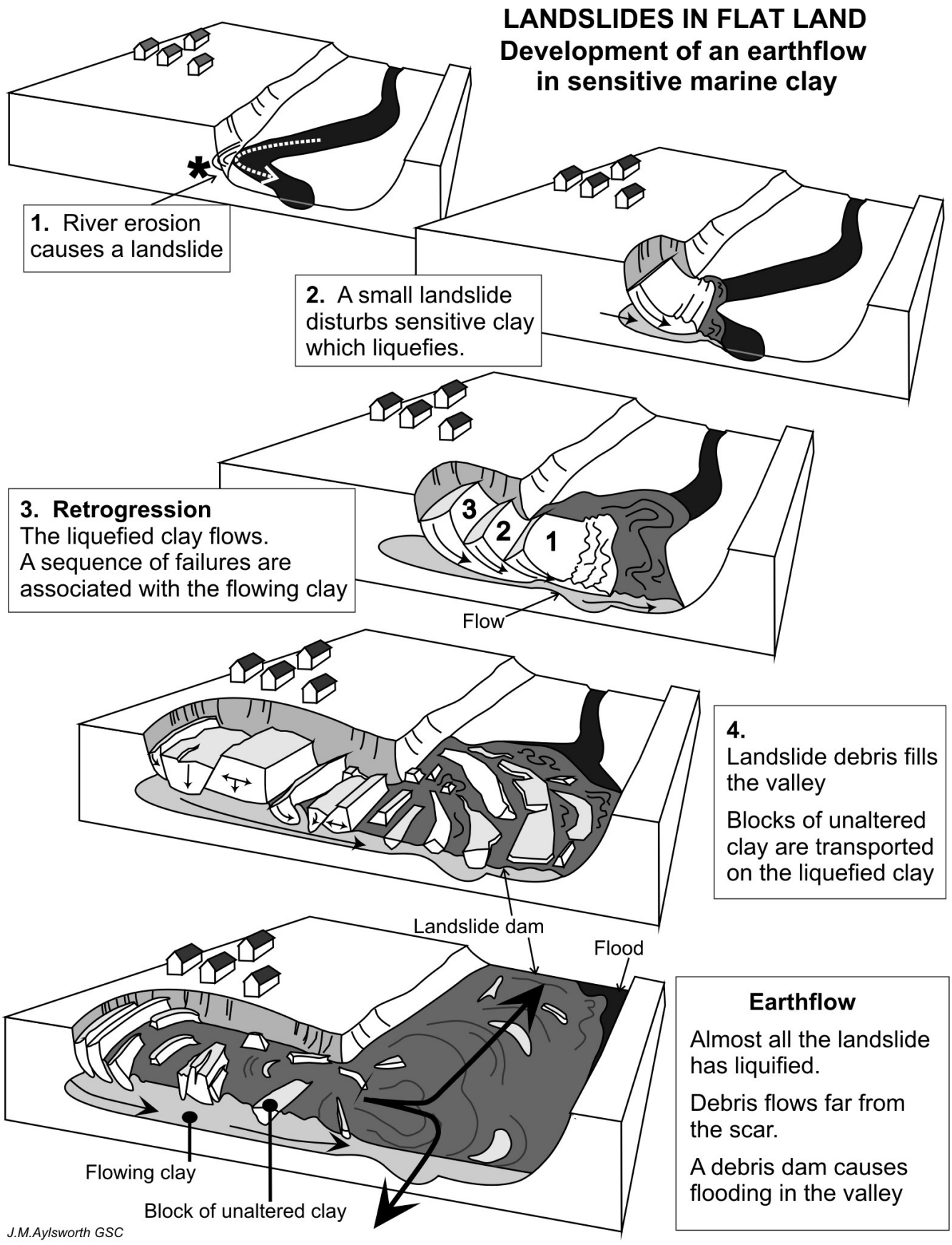
   A. assess what criteria would be used to determine a landslide risk assessment for building construction , noting differences for houses, office buildings and roads
   B. identify the appropriate land uses for risk prone areas
   C. propose engineering solutions to slope instability

   Points are summarized in student notebooks.

To help classroom discussion, a summary of possible methods of risk reduction is attached here.

Risk Reduction

Alternative Methods	Advantages	Disadvantages
Do nothing		• Risk remains
Relocate people	• Eliminates risk to life and to movable assets	• Expensive? • Public may be reluctant • Does not eliminate other impacts resulting from a future landslide (i.e. floods at a landslide dam, etc.)
Revegetate the slope	• Provides added stability when used in conjunction with structural methods • Reduces erosion on bank	• Not a primary method of stabilization
Change the slope	Excavation to reduce the angle of slope • Increases slope stability	• Requires excavation and disposal of a large volume of earth • Potential habitat damage • Expensive, if required for a large area
Stabilize the slope (engineering methods)	Geotechnical stabilization methods (retaining walls, rip-rap, berms, etc.) • increases slope stability and reduces erosion	• Visual impact • Potential habitat damage • Expensive, if required for a large area
Improve the drainage	Methods to improve internal and surface drainage of soil (drainage tiles, artificial ravines, etc.) • Increases slope stability • Reduces the level of the water table • Some methods also prevent slope erosion	• Expensive, may require large-scale earth moving • Requires maintenance • May also require other methods
Advanced Warning Alarm Systems	• May reduce risk to loss of life • Most effective for the properties that are furthest from the slope	• Risk to property remains • Installation and maintenance problems • Chance of false alarms causing public indifference • Is there time to evacuate?


LANDSLIDES IN FLAT LAND
Development of an earthflow
in sensitive marine clay
1. River erosion causes a landslide
2. A small landslide disturbs sensitive clay which liquefies.
3. Retrogression
The liquefied clay flows.
A sequence of failures are associated with the flowing clay
3
2
1
Flow
4.
Landslide debris fills the valley
Blocks of unaltered clay are transported on the liquefied clay
Landslide dam
Flood
Earthflow
Almost all the landslide has liquified.
Debris flows far from the scar.
A debris dam causes flooding in the valley
Flowing clay
Block of unaltered clay
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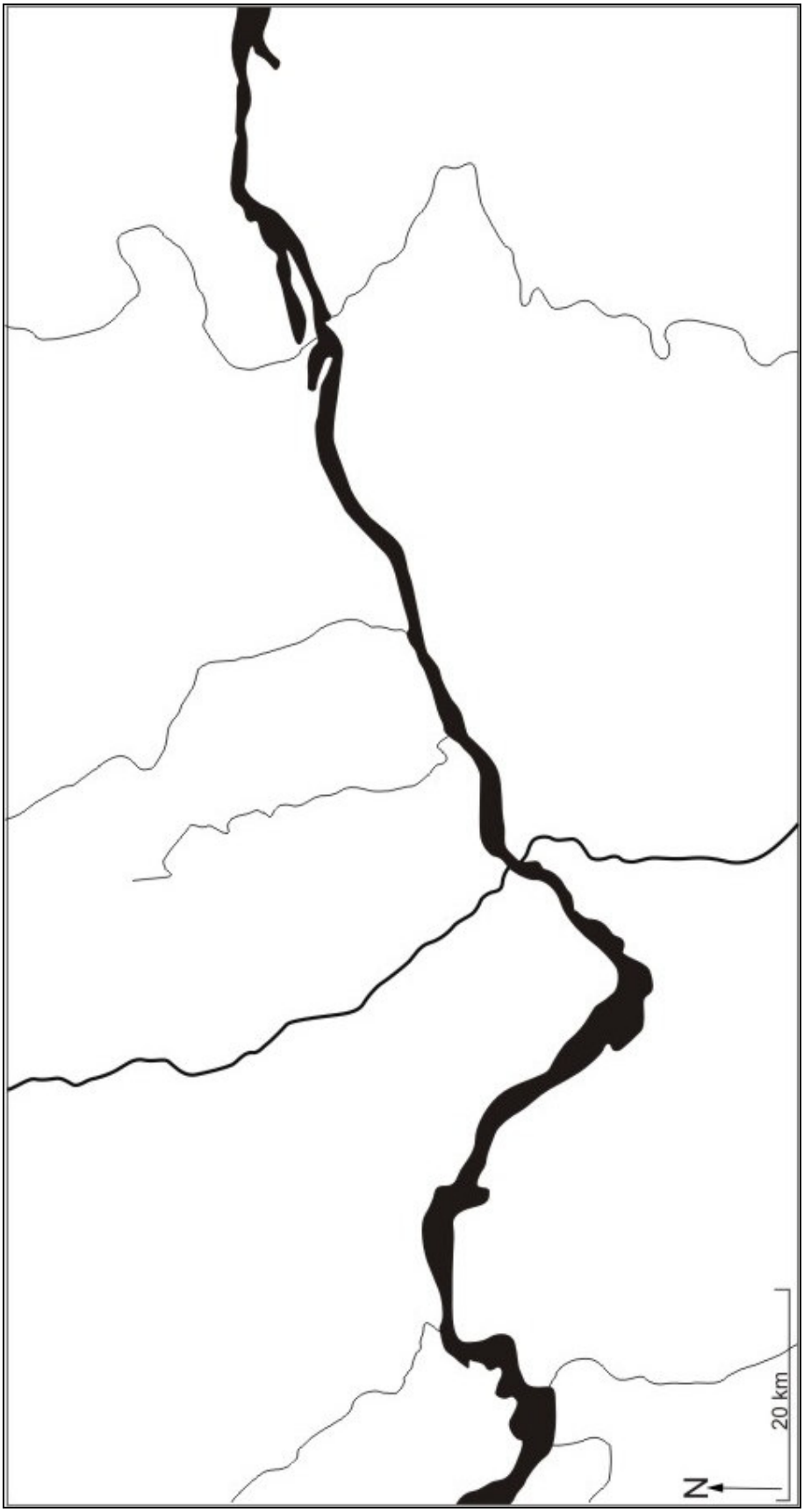
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