**Cooperative Watershed Mapping**

**Preparation: Construction of Trickle Flow Apparatus**

**Materials for a class of 30 students (6 groups of 5 students)**

Use 7-750 mL margarine or yogurt tubs with lids.

Drill bits of about 1/8”-3/8”

36m Twine or light twisted (not braided) rope

Masking or duct tape

5 large bags of cornmeal, or other free-running granular or powdered material

Note: Sand might run out too fast. Salt and sugar pose cleanup problems and are even more difficult to use in damp situations than corn meal.

Drill a hole in the bottom of a recovered container (e.g. 750 mL yogurt tub) large enough that the free-flowing material of choice can flow out of the hole at a steady rate, providing between 3 – 5 minutes of flow as from an hourglass. You will have to experiment with hole size for your material of choice. A hole of about ¼” works for cornmeal. Using two 3 m lengths of twine or light rope, construct handles by untwisting both pieces of the twine at the midpoint so that the container will fit into the untwisted section. Arrange the four handles so that they come out at 90o angles to each other (Fig. 1). Secure these handles with masking or duct tape.

 **Side view Top view**

**Figure 1. Trickle Flow Apparatus:** A hole drilled in the bottom of a recovered container allows a free running material to trickle out. The flowing material represents precipitation and marks a watercourse. The location and movement of the container is controlled from 4 corners by students via the twine handles which are secured in place by masking or duct tape.

**MINDS ON**

Using a relief map that includes waterways, students will identify the factors that affect the course (shape) of waterways. They will share these with a partner, then contribute to the class list.

**Guiding questions:**

What geographic features will cause water to go one way or the other?

***Slope/ incline, barriers (continental divides, ice, dams), random formation of drainage furrows, differences in soil type or particle size.***

Can you see these on your map?

***The teacher will have chosen a relief map, or a variety of types of relief maps that illustrate these features. Students should be able to feel or see contour lines or shading to represent altitude., Certain types of barriers will not be shown on maps and differences in soil type/ particle size will only be on special types of maps.***

How are they shown on the map?

 ***Slope: 3D features, contour lines, or shading; same with soil types***

What characteristics of soil might allow water to go in a particular direction?

***Coarser particles allow water to flow through it more easily (e.g. gravel); Sand erodes easily, clay erodes less easily.***

What force(s) affect the direction that water flows?

 ***Gravity is essential; Erosion (wind, rain, flowing water),***

What might affect the speed of the water?

 ***Volume of water, angle of the slope, shape of the channel***

Does the size (width and depth) of the watercourse change from its origin to its mouth?

How does it change? Why does it change?

***Yes. More water joins the water course from tributaries or the floodplain, so the volume and therefore the width may increase. Changes in width or depth may cause variations (e.g. narrowing/ deepening as in a canyon, broadening/ becoming shallow as on a floodplain, water sinking through coarse sediments in a riverbed to flow underground), but the volume of water generally increases.***

The teacher will then briefly demonstrate the trickle flowapparatus above a tray to show its basic functioning and to demonstrate factors that affect flow.

**Guiding questions:**

What would happen if we changed the size of the hole?

***More material would flow out, flow rate would increase, we would run out of material faster.***

What would happen if we changed the shape of the hole?

***More complex shape (instead of round) would mean there was more drag caused by the edge of the hole on the material flowing out. It would flow a bit slower. Students may want to experiment with this and you may want to have alternatives ready for them to try, possibly as enrichment if needed.***

What would happen if we used this apparatus on the moon (less gravity) or on Jupiter (more gravity)?

***Less gravity, lower flow rate; More gravity would increase the flow rate.***

What would happen if we used a material inside the container that was more denser?

***Same as above: denser would mean it would tend to flow out more quickly.***

**ACTION!**

Prior to class, tape the bottom hole of each container from the outside. Fill the container with the corn meal or other free-flowing material, and cover the containers with the lids. These can be given to students once they are outside and spills will be less of an issue.

The teacher should review teamwork skills and point out challenging steps where students might encounter difficulties. Specific instructions are provided by the teacher with demonstrations and on the student handout (BLM3: Mapping Instructions). Use a compass and identify north and review the cardinal and intermediate directions.

Working in groups of 5, students will decide their respective roles within their groups and collect their equipment and follow the student instructions. Once they have accomplished this preliminary plan, the teacher will check their progress through questioning and if appropriate, provide them with their trickle flow apparatus filled with free flowing material and sealed with tape and lid.

Once the container is empty or all the rivers are drawn, the students will draw their watershed. This can be done by one student (data recorder) while other students assist with the placement of the metre sticks to identify the location of various headwaters and convergences of watercourses. Alternatively all of the students could practice drawing a map to scale to improve their mapping skills. In order to make their map more authentic, they will add the standard components of a map (e.g. compass rose using the direction provided by the teacher’s compass, legend, caption) and should name the major features and tributaries of their watershed.

**Student Handout: Analysis Questions**

Questions 1 and 2 will vary depending on the group, but should be checked for completion.

1. Identify 3 factors that affect the flow of water across a landscape. Be sure to explain how each factor affects the flow (3 I).

***a) Slope: higher slope means faster flow***

***Direction of slope, turns, angles, or barriers: A change in the direction of ‘downhill’ means the watercourse will change direction. The outside part of a bend will tend to erode while the inside part of a bend will receive deposits from the stream flow.***

***b) Volume: more water will have a greater effect. Small amounts of rain or snowmelt will seep into the ground or be absorbed by plants. Large amounts will become runoff, flowing across the surface of the ground, accumulate in low areas and form streams which will merge to form rivers.***

***c) Soil/ sediment type: different textures of soil or sediment have different abilities to absorb water and resist erosion. Water percolates quickly into sand, but sand is very susceptible to erosion. Clay absorbs water slowly, but is less susceptible to erosion because its particles are so small.***

***d) Vegetation: Plants absorb water, but their roots also help resist erosion.***

***(Your class may come up with other factors. Discuss the likelihood of different options.)***

1. Identify 3 factors that may have affected the flow of cornmeal from the trickle flow apparatus. Be sure to explain how each factor affects the flow (3 I).

***a) Size of hole: larger hole means faster flow and less clogging***

***b) Shape of the hole: a round hole has less edge vs. area. A square or star-shaped hole would have more edge vs. area and would tend to clog more easily because there is more drag between the moving material and the edges of the hole.***

***c) Moisture content of material: drier material flows more easily and won’t clump up and clog the hole***

***d) Texture of material: finer ground material flows more easily***

***e) Type of material: some material tends to clump or get stuck more easily***

***f) Jiggling: moving or tapping the reservoir helps unclog the apparatus, and makes sure that there is loose material next to the hole***

***(Your class may come up with other factors. Discuss the likelihood of different options.)***

**Cleanup:**

There are options for the material you use in the trickle-flow apparatus, but the material should be visible against the garbage bag, flow easily through the apparatus, not be toxic to students or the environment, and either be biodegradable or easy to pick up again. Most of the material can be recovered by lifting the corners of the green garbage bag to make the material pool in the middle of the bag. The material can then be poured from the green garbage bag into a container. Salt will kill grass, but could be used on asphalt and then swept up. Sugar may attract pests (e.g. ants, wasps) unless spilled sugar is raked and watered into the grass immediately.

**Indoor Option:**

To replace the trickle flow apparatus, the original map will be drawn on chart paper taped to the floor or a large dry erase slate and transcribed onto graph paper as described for the outdoor version. Students will use a marking pen taped to a bean bag (or any weight that will allow enough pressure on the drawing surface) and controlled by twine handles as in the original version.