HOW MUCH WATER: WHEN? WHERE?

Climate is becoming evermore unpredictable and flooding events are becoming more frequent; the Forest Watershed Research Centre has pioneered a mapping approach to locate potential flood risks

AS severe weather and flooding events become more frequent and more damaging, it is increasingly important to know which areas are particularly prone to flooding. While many flood risk assessments exist for developed areas with high population densities, they are generally too expensive to apply across entire provinces or countries. To assist, a new mapping approach pioneered and developed at the University of New Brunswick, Canada, provides a way forward to visualise and map where the land would generally be dry or would get wet and potentially flood. This approach is, for the most part, based on digital elevation models (DEM), as illustrated in Fig.1. The resulting maps, referred to as wet areas maps, are becoming must-have data layers for forward planning across many jurisdictions, and are currently being adopted by forest, park and resource managers, community planners, and developers. Applications vary by planning purpose, for example:

- Developers need to accommodate incoming storm water to avoid flooding;
- Wet area and flow channel crossings by roads and trails need to be quantified and minimised;
- Tower and campground locations and foundations should be dry;
- Off-road traffic needs to be timed properly to avoid soil compaction and rutting; and
- Wet areas mapping provides a means to delineate variations in soil moisture regimes, wetlands, and wildlife habitats and corridors with unprecedented resolution.

How does it work?

The wet areas mapping process involves generating flow direction, flow accumulation, flow channels and associated cartographically

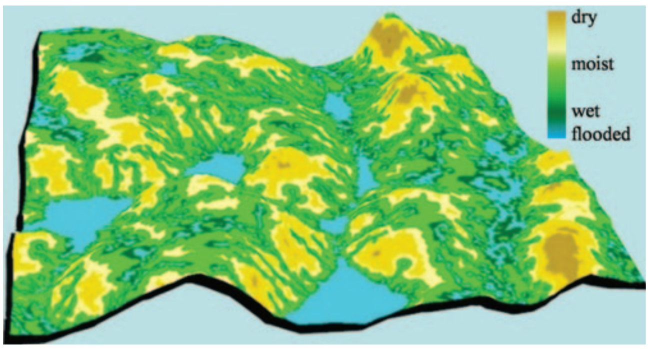

Fig. 1

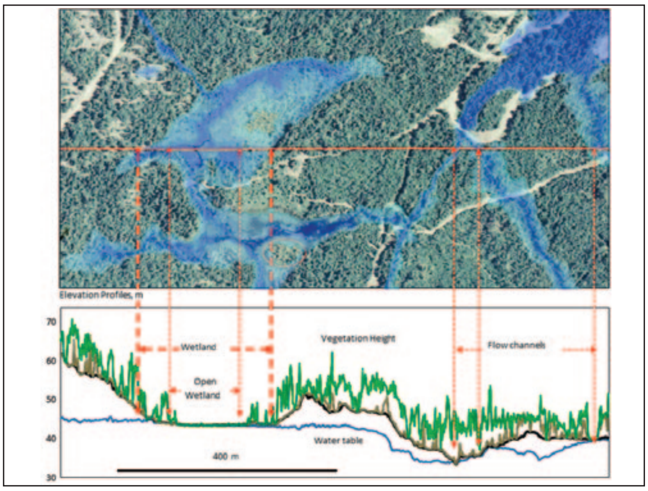

Fig. 2

defined wet areas next to flow channels, and open water surfaces from DEMs. All of this can then, among other things, be related to (i) vegetation type and height, as illustrated in Fig. 2, and (ii) to local hydrological infrastructure such as roads and dams.

Since DEMs are available globally at 90 and 30 metres, and since many jurisdictions have DEMs available at 10m resolution or better, wet areas mapping can be done to comprehensively reveal hydrological conditions across large areas anywhere. Typically, such maps correspond closely with image-captured dry *versus* wet areas patterns.

Fig. 3 shows a subtropical area in Africa (50x40km) where the land is moist to wet along flow channels (coloured green) and is dry to in-between (coloured yellow to red). It has been suggested that community, transportation and conservation planning for areas like this and elsewhere would benefit greatly from wet areas mapping. While wet areas mapping does not replace the requirements for standardised flood risk assessments, it will prove a convenient base to assess general flood risk potentialities across large areas.

As DEM resolution increases by way of new elevation surveying technologies such as LiDAR (Light Detection and Ranging), wet areas mapping accuracy increases as well, to the point that it can be interfaced with the development, design and construction of local hydrological infrastructure, including roads and ditches. In this way, existing structures can be evaluated in terms of their current capacity to retain or divert water according to past, current and future events. The illustration (Fig.4) for a 4x2km area shows how LiDAR DEM-generated wet areas mapping differs by season and where the corresponding numbers refer to minimum upslope water contributing areas for channel flow initiation. Typically, developments do not and should not occur in areas that are permanently wet. In addition, most road-stream crossings with a one hectare upslope water contributing area require and receive proper culvert placements to avoid seasonally or weather-affected road washouts.

Aiding initiatives

Wet areas mapping also interfaces with local to regional initiatives concerning climate change adaptation, soil and water conservation, crop management, and sustainable land use practices. For example, potential crop productivities in forestry and agriculture can be optimised by the local in-field soil wetness variations. Inland wet areas are best used for wet area farming practices, wetland and wildlife conservation, and storm water management. Low lying coastal areas need special hydrological infrastructure designs that, by way of wet areas mapping, can accommodate not only sea surges but also need to drain inland water.

Ultimately, as wet areas mapping would enter the public domain through knowledge exchange, education and real estate evaluations, it will become known how each parcel of land is hydrologically situated within its general neighbourhood. Downslope parcels could, for example, be affected by increased upslope water retention, soil wetness, soil erosion, gully formation, slope destabilisation, mudslides and flooding. The bottom line is that better information about inland and coastal water dynamics leads to better technical, financial and socioeconomic decision making in the short and long term.

Technology

From a technical perspective, wet areas mapping at high resolution requires specialised expertise and algorithms to compile, configure, read, process and store terabytes of information in a relatively short time as the demand for wet areas mapping and related products increases over time. As such, great care has gone into the development of highly efficient software and tools to intelligently manage and process the data required for seamless high resolution mapping at large scales. The maps produced conform to user-specified GIS formats, including PDFs. End users refer to federal and provincial governments, industries, municipalities and private landowners. One popular wet areas mapping application refers to the TRAIL tool, which allows users to optimise and/or evaluate existing or contemplated road and trail layout across landscapes interspersed with steep slopes, flow channels, and/ or wet ground. TRAIL user perspectives range from laying out logging roads, all-terrain vehicle and mountain bike trails, and hiking trails. Foresters use wet area-generated maps and trails for meeting best forest management practice specifications in their silvicultural prescriptions, including harvest block layout, and wet areas maps for onboard off-road navigation along prescribed cutting and wood-forwarding patterns. Other applications deal with, for example, bracketing the extent of oil spills from pipelines, and mapping the extent of water retention when hydrological infrastructure works as designed and when it fails altogether. Similarly, the mapping process should find applications within the general context of soil and landscape remediation, specifically, and landscape architecture in general. For further details, visit watershed.for.unb.ca/.

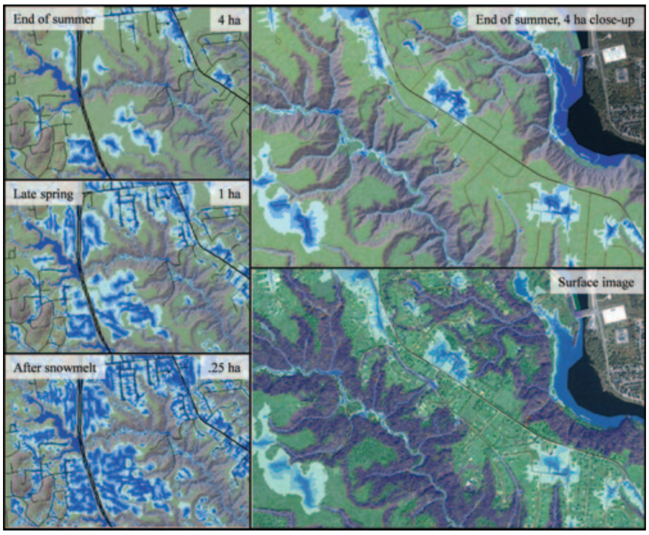

Fig. 4

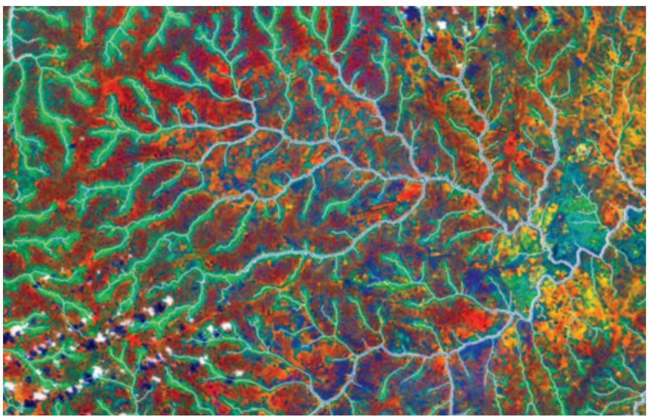

Fig. 3

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