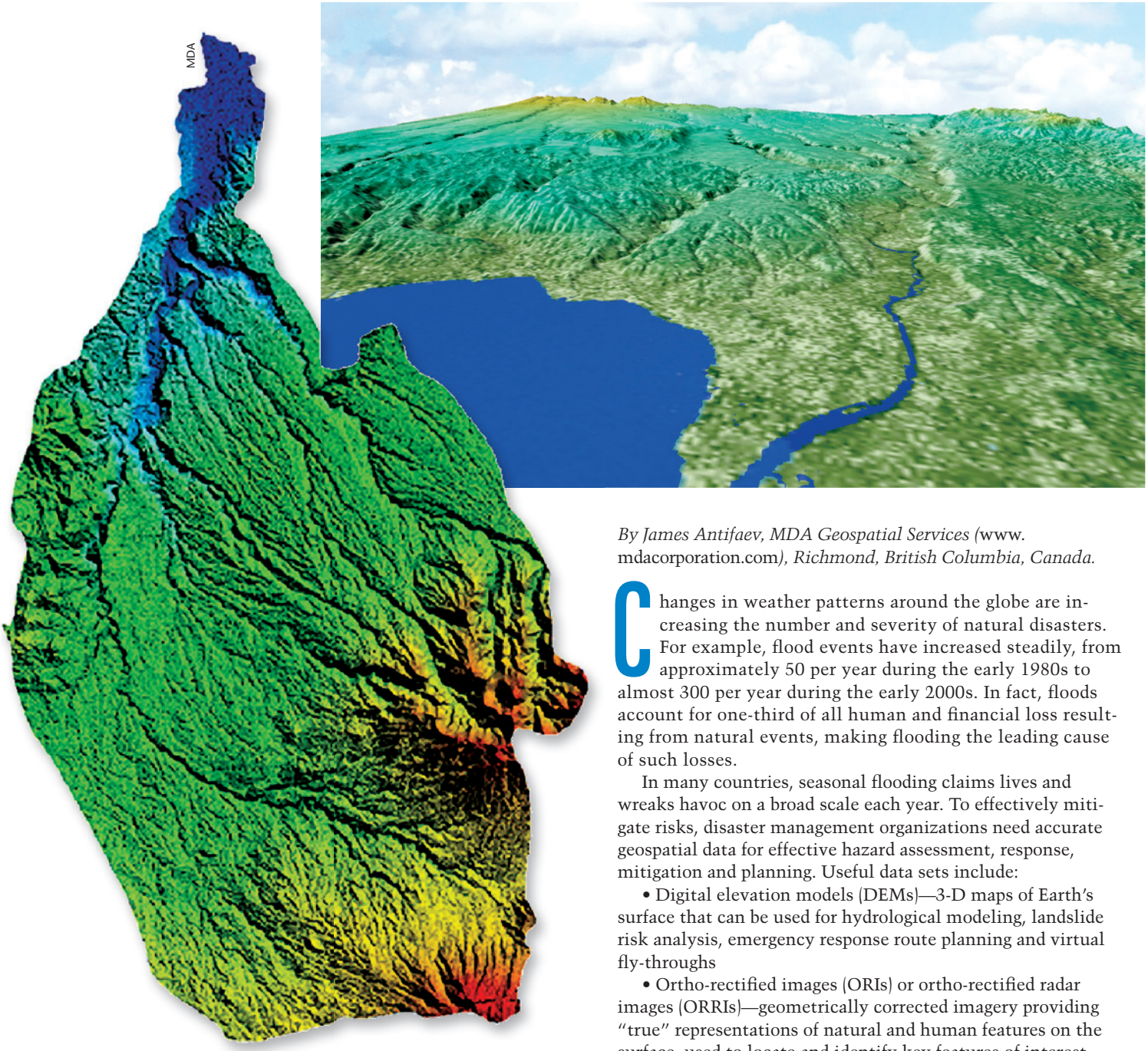
Empowering Broad-Area Disaster

SAR complements LiDAR data to enable effective national-scale coverage for disaster planning and mitigation.



A shaded relief image of Cagayan de Oro, Philippines, provides a 3-D perspective of a DEM (inset) derived from RADARSAT-2 imagery.

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Changes in weather patterns around the globe are increasing the number and severity of natural disasters. For example, flood events have increased steadily, from approximately 50 per year during the early 1980s to almost 300 per year during the early 2000s. In fact, floods account for one-third of all human and financial loss resulting from natural events, making flooding the leading cause of such losses.

In many countries, seasonal flooding claims lives and wreaks havoc on a broad scale each year. To effectively mitigate risks, disaster management organizations need accurate geospatial data for effective hazard assessment, response, mitigation and planning. Useful data sets include:

- Digital elevation models (DEMs)—3-D maps of Earth's surface that can be used for hydrological modeling, landslide risk analysis, emergency response route planning and virtual fly-throughs
- Ortho-rectified images (ORIs) or ortho-rectified radar images (ORRIs)—geometrically corrected imagery providing "true" representations of natural and human features on the surface, used to locate and identify key features of interest such as buildings, infrastructure and water bodies

Management

• Drainage Networks—useful for hydrological analysis and flood preparation

• Flood Maps—generated while floods are happening to show the location and extent of flooding

Employing Cost-Effective Data

While most disaster management agencies have suitable geospatial data for limited urban or developed areas, it has been a challenge to obtain accurate, current information for rural areas. Rural areas tend to be large, and to date the cost to create maps and models for such areas has been prohibitive. As a result, the data available for rural areas typically are either decades old or of insufficient quality for accurate flood hazard analysis.

Satellite-based synthetic aperture radar (SAR) is a cost-effective approach for broad-area data acquisition in places that otherwise would be too expensive to cover. MDA's RADARSAT-2 satellite has unique capabilities that make it the ideal platform for quickly and cost-effectively mapping and monitoring large areas. As a recent example, MDA is producing a suite of geospatial products for the University of the Philippines' Disaster Risk and Exposure Assessment for Mitigation (DREAM) program (see "Providing Solutions for a Disaster Hot Spot," page 34), which will provide a national data set for managing the threat of flood and landslide risk. The data set will combine multiple data sources, including light detection and ranging (LiDAR) and SAR imagery, to provide timely, cost-effective coverage of the entire country.

DEM Options

There are several options available to produce DEMs. As detailed in the chart below, each solution has a unique set of strengths and weaknesses that should be evaluated when determining the right technology for a particular application.

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As a provider of a complete range of geospatial solutions that support disaster management, MDA has developed a suite of capabilities that enable effective flood

DEM Development Options

DEM Technology	Cost/km²	Data Collection Rate	Post Spacing	Vertical Accuracy	Strengths	Weaknesses
Aerial LIDAR	Highest	Lowest	1 m	0.1-1 m	• Highest accuracy • Excellent for small areas (urban cores or mine sites)	• Affected by weather • Requires flight planning authorization • LIDAR doesn't provide imagery
Aerial Photo	High	Medium	1 m	<1-5 m	• Good for small and medium-sized areas • Also provides high-resolution ORIs	• Affected by weather and cloud • Requires flight planning authorization
Aerial IFSAR	High	Medium	5 m	1-5 m	• Image collection through cloud possible	• Can still be affected by adverse weather • Requires flight planning authorization
Very High Resolution Optical Satellite	Medium	High	2-10 m	2-10 m	• Highest accuracy available using satellites	• Affected by cloud and weather
SAR Satellite	Lowest	Highest	5-10 m	5-15 m	• Fastest and lowest cost option for national and regional scale projects • Rapid acquisition of huge areas • Image collection in any weather conditions	• Efficiencies for large areas don't scale linearly to very small areas
Shuttle Radar Topography Mission (SRTM)	Free	Archive Only	90 m	5-16 m (some high-relief areas have voids)	• Freely and immediately available for most places	• Data are more than a decade old • Post spacing (grid size) not suitable for many applications • Voids in some areas

Providing Solutions for a Disaster Hot Spot

Disaster management professionals in the Philippines are familiar with the damage caused by annual flooding. Since 1900, the Philippines has experienced more disasters than any other country in the world.

Most disaster events are caused by tropical cyclones. In 2011 alone, 19 storms crossing the Philippines caused more than 1,500 deaths and $640 million in damage. To help mitigate the damage caused by these annual events, a team at the University of the Philippines (UP) will conduct the country's most detailed 3-D mapping program ever. With the support of the national government through the Department of Science and Technology's Nationwide Operational Assessment of Hazards, UP initiated the Disaster Risk and Exposure Assessment for Mitigation (DREAM) program.

• High-accuracy RADARSAT-2 DEMs will be provided for the key river catchment areas, along with 3-meter-resolution orthorectified radar images, water body maps and drainage networks.

• Standard RADARSAT-2 DEMs will be provided for the rest of the country, enabling unprecedented coverage of remote regions at risk from flooding.

Timeliness is a key program component. Within six months from the start of the contract, MDA will deliver DEMs for the Philippines' entire 300,000 km^2 land mass, providing coverage not possible with other sources in the same detail, time or budget. Enrico C. Paringit, head of the DREAM program, explains the complementary approach.

"There is a need to strike a balance between cost and the level of detail required for disaster management," he says.

MDA

MDA will provide a suite of DEMs, ORRIs, drainage network maps, ORIs and flood maps to support the DREAM program's disaster management objectives.

The DREAM program will combine RADARSAT-2 digital elevation models (DEMs), covering the entire country with sub-meter light detection and ranging (LIDAR) data for key urban centers. In planning for the program, UP recognized that elevation data of different resolutions are needed for the country's different regions.

MDA will provide data at two levels of accuracy, providing higher accuracy products for key flood zones while enabling complete but efficient coverage for the rest of the country:

"MDA is in a unique position to fill in a certain niche in the DREAM program, particularly in hydrological analysis. RADARSAT-2 DEMs are well suited for our computer models that simulate water discharge from mountainous catchment regions. The LIDAR data provide a level of detail fit to describe inundation in the flood plains. Getting a DEM with intermediate accuracy specifications to meet both the requirements of watershed hydrology and flood plan analysis would fall short of the program's expectations in terms of accuracy, quality and timeliness."

hazard management at national scales. These capabilities include the ability to rapidly generate DEMs for hydrological modeling and landslide risk analysis, ORRIs for accurate feature identification, and broad-area flood monitoring services that determine the extent and location of flooding during storms.

With high accuracy and resolution, these products are a significant improvement on the existing data in many countries, giving disaster management agencies the accurate, up-to-date information they need to do their job. SAR-based DEMs also represent the fastest, most cost-effective way to update topographic information for large areas compared with aerial, optical satellites or other means.

RADARSAT-2 collects data through clouds, regardless of weather or lighting conditions, making it the most reliable tool for collecting data in flood-prone countries that experience regular cloud conditions. In addition, RADARSAT-2 has unique imaging modes that combine excellent resolution with wide image swath widths, enabling the satellite to cover large areas faster than other aerial or space-based options. The Multi-Look Fine Wide imaging mode combines 5-meter resolution with image swath widths of 90 kilometers, making it an ideal choice for collecting data of national-scale areas. The satellite's Wide Ultra-Fine imaging mode, with a resolution of 3 meters and swath width of 50 kilometers, is well suited to regional areas such as river catchment areas or flood basins, where greater detail is of most value.

Optimizing Disaster Management

With a proven international record of responsiveness and accuracy spanning 18 years, MDA believes the value of RADARSAT SAR data as a key component in multitiered strategies of disaster mitigation, assessment and response will continue to be embraced by countries around the world. David Belton, general manager of MDA's Geospatial Services business, is excited about the prospects.

"With increasing customer knowledge about the cost and schedule benefits of satellite SAR compared with optical satellites and aerial sources, we're seeing more organizations interested in employing broad-area RADARSAT-2 coverage," he says. "By enabling people in national and state-level agencies to quickly and cost-effectively map larger areas, we're helping them better fulfill their mandate to mitigate risk throughout the country without having to narrow their focus to small areas due to cost constraints."

RADARSAT-2 currently provides access to the world's highest capacity SAR satellite. MDA's participation in the future RADARSAT Constellation Mission ensures the company will remain a primary global source for 24-hour all-weather SAR imaging. MDA's solutions enable organizations such as the University of the Philippines to conduct extensive local, regional and national mapping programs using the latest technologies, supported by an organization focused on operational support. The results of those efforts will support more effective disaster management plans that will reduce the impact of seasonal and event-based flooding across the globe. In doing so, these programs have the potential to save millions of lives and reduce damage to vital infrastructure central to the economies of the nations affected. EIJ

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