# COMPARING SCIENTIFIC AND SCIENCE HAZARD APPLICATION REQUIREMENTS FOR DESDYNI

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## 1. INTRODUCTION

The involvement of applications community in the development of NASA's Decadal Survey Mission requirements greatly expands the functionality of the mission to include cross discipline research, opens new collaborative opportunities, and can significantly augment science unrelated to the primary missions goals: the applications community are users of the mission data that do not necessarily contribute to the primary science objectives of the given mission. NASA, USGS, and California Hazards Research Institute cosponsored an applications workshop in the Fall of 2008 to evaluate various application requirements for the DESDynI mission – Deformation, Ecosystem Structure and DYnamics of Ice, schedule to launch in 2013-2018 timeframe [1]. The science objectives of the mission are to: 1) determine the likelihood of earthquake, volcanic eruptions, and landslide; 2) predict the response of ice sheets to climate change and the impact an sea level; 3) characterize the effects of changing climate and land use on species habits and carbon budget; and 4) understand the behavior of subsurface reservoirs. Scientists from application fields of geohazards, hydrology, oceanography, petroleum and carbon sequestration, and forest and ecosystem management discussed specific mission requirements for a DESDynI 'like' mission, a synthetic aperture radar (SAR) system combined with multibeam LiDAR sensor, that would best address their science needs. This paper explores DESDynI mission requirements (coverage, latency, products) for hazard science and hazard applications in the areas of solid earth hazards (earthquakes, volcanoes, and landslides), floods, coastal inundation, and anthropogenic/unexpected events.

## 2. SOLID EARTH HAZARDS

There are many similarities between the DESDynI mission requirements for solid earth science hazards and applications, but there are some key differences. The science objectives are to understand and model the fundamental natural processes that produce hazards, understand what processes contribute to when and how the natural processes become hazardous, and improve forecasting and prediction tools that untimely help mitigate the hazards and their impacts on society. The objectives of applications community are to quickly characterize the disaster, assess its impact on the community and infrastructure, monitor and track the progress of the disaster until its influence has abated, and then fold the science learned from the event into future mitigation efforts and legislation that reduce the loss of life and property. The mission requirements for the science and applications communities significantly overlap, both need to have an up-to-date baseline data archive, rapid tasking to ensure that the satellite is collecting data with every possible orbit, and adequate spatial coverage of the target. The key differences in the mission requirements are in the data latency, product generation, and data distribution. The applications community, namely the emergency responders, need to have rapid access to the most recent imagery in a form that is easily understood and can be directly imported as georeference imagery into their custom GIS systems. For many of the hazards, the ability to have high frequency (daily or better) data is needed to develop and maintain the situational awareness for the responders. Imagery and products that take days to weeks to produce are of little assistance in guiding the emergency responder activity. There is also a desire from the science community to have low frequency or regularly acquired data to capture post-event transients. For example, the surface continues to deform over the days, weeks, months and years after larger earthquakes, all depending on the geologic structure of the area and viscoelastic properties of the lower crust and upper asthenosphere. The regularly acquired interferometric SAR images can then be used to track the decay rate of the post seismic deformation [1]. Obviously, both the science and applications communities' benefit from the high frequency imagery, even though the same imagery is being used for vastly different uses.

## 3. FLOODING AND COASTAL INNUDATION

Surface water hydrology is currently not part of the DESDynI science mission, but the mission itself can provide invaluable scientific data to advance our fundamental understanding of hydrology as well as provide a number of applied uses for the data including emergency response. Since satellite radar is a cloud penetrating technology, DESDynI can acquire snapshots of flooding extent, water level changes (primarily in wetland environments), water flow direction, inundation extent and duration, as wells as wind speed in open water that are not as readily or consistently available from optical satellite sources. Hydrology hazards have similar mission requirements as the solid earth hazard applications, where they need to have an up-to-date baseline data archive, rapid tasking to ensure that the satellite is collecting data on every possible orbit, adequate spatial coverage of the target, and data quickly delivered in a georeferenced format that is easily disseminated to the emergency responders. The addition of polarimetric SAR capabilities would provide improved subcanopy imaging and characterization of the flood extent and would likely provide better estimates of the vegetative frictional contribution in the storm surge modeling [1]. Data frequency needs for the emergency responders are daily with sub-daily optimum for hazard response. Flooding and coastal inundation science would also greatly benefit from the high frequency data collection to assess flood duration, inundation zones, draining and habitat response.

## 4. ANTHROPOGENIC AND UNEXPECTED HAZARDS

There is a wide array of hazards that are truly difficult to predict. Many hazards, such as earthquakes, volcanoes, hurricanes, are in areas with long histories of the likelihood that an event will transpire at some point; the gulf coast states of the United States will be influenced by hurricanes, the mid-western U.S. has tornadoes, California has a long history of earthquakes and the state of Hawaii is on a volcanic hot spot. Collecting baseline data for an area with a known hazard are straightforward, however, hazards that either occur so infrequently or are truly unexpected my be more difficult to routinely collect for baseline data, especially if baselining interferes with the primary science objectives of the given mission. For instance, SAR and InSAR imagery can be used to track fires, oil spills, karst failures, injection induced seismicity, mine collapses, and ice dams. The emergency response mission requirements are similar to the solid earth hazard applications: the need for immediate satellite tasking, daily or better satellite frequency and data latency on the order of a few hours. Some of these hazards are single events, such as a mine collapse or dam failure, but many may last for days to weeks – with fires and large oil spills as examples. In these cases, the ability to track the spatial spread of the event and the delivery of high quality products with minimal data latency ensures that the imagery product is of value and relevant to the emergency responders.

## 5. SUMMARY

The involvement of the applications community in the design and development of the NSASA Decadal Survey Missions will greatly expand the cross-discipline research opportunities from the same data source. The DESDynI Applications Workshop is an excellent example of bringing both the science and applications communities together to define a satellite mission that has a broader cross-discipline base than previous missions.

## 6. REFERENCES

[1] A. Donnellan, G.W. Bawden, and J. Rundle, "Report of the DESDynI Applications Workshop", October 29-31, Sacramento, CA. 2009. http://desdyni.jpl.nasa.gov/applications/