Tsunami Hazards

Coastal Hazard Presentation Handout
LCDC/DOGAMI Governing Board Meeting
September 26, 2013

ORS 455.446 (SB 379) line

The DOGAMI Governing Board is required by ORS 455.446 to determine the tsunami inundation zone which is used to determine building code requirements. These statutes were enacted in 1995 as a result of Oregon Senate Bill 379; the regulatory maps are thus sometimes referred to as "SB 379 maps."

These regulatory maps are not intended for emergency evacuation purposes and do not necessarily represent tsunami inundation from a worst-case event. Rather, the maps show the best estimate of tsunami inundation from a typical or most likely tsunami originating from earthquakes on the Cascadia subduction zone fault (located on the seafloor near the Oregon coast). The regulatory maps are based on scientific knowledge available in 1995.

ORS 455.446(1) (a) provides that certain types of new buildings may not be constructed within the tsunami inundation zone:

- Hospitals and other medical facilities having surgery and emergency treatment areas (ORS 455.447(1)(a)(A))
- Fire and police stations (ORS 455.447(1)(a)(B))
- Communication centers and other facilities required for emergency response (ORS 455.447(1)(a)(G))
- Schools with a capacity greater than 50 persons, including public, private or parochial through secondary level and including child care centers (ORS 455.447(1)(e)(B))
- Colleges or adult education schools with a capacity greater than 500 persons (ORS 455.447(1)(e)(C))
- Jails and detention facilities (ORS 455.447(1)(e)(E))

ORS 455.447(4) requires a consultation process with DOGAMI for certain other types of new buildings that are proposed within the tsunami inundation zone:

- Structures and equipment in emergency-preparedness centers (ORS 455.447(1)(a)(E))
- Hazardous facilities, meaning structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be of danger to the safety of the public if released (ORS 455.447(1)(b))
- Major structures, meaning buildings over six stories in height with an aggregate floor area of 60,000 square feet or more, every building over 10 stories in height and parking structures (ORS 455.447(1)(b))
- Public assembly structures with a capacity greater than 300 persons (ORS 455.447(1)(e)(A))
- Medical facilities with 50 or more resident, incapacitated patients (ORS 455.447(1)(e)(D))
- All structures with a capacity greater than 5,000 persons (ORS 455.447(1)(e)(F)

ORS 455.446 – .447 do not apply to existing buildings, "fire or police stations where there is a need for strategic location," or where "there is a need for the school to be within the boundaries of a school district." ORS 455.446 also includes a process for the DOGAMI governing board to grant other exceptions.

In 2009-2010, DOGAMI led two pilot projects aimed at development of a robust, scientifically defensible approach to tsunami inundation mapping for the Oregon coast. Both projects sought to calibrate the latest theoretical tsunami and fault rupture models to available geophysical and geological data with emphasis on offshore and onshore geologic "footprints" of past Cascadia subduction zone (CSZ) earthquakes and tsunamis – the most catastrophic natural hazard facing the Oregon coast.

The first project, led by Dr. George Priest, focused on Cannon Beach where there is a good record ancient tsunami deposits in the Ecola Creek marsh. Dr. Rob Witter mapped the deposits utilizing punch cores thus establishing minimum inundation for Cascadia tsunamis over the last few thousand years. In addition, Dr. Chris Goldfinger of OSU made available a geologic record of CSZ earthquakes gleaned from deposits of sand and silt shaken onto the ocean floor over the last 10,000 years, the relative thickness of each apparently correlating with relative earthquake size. The length of time between these deposits gave another clue about how long the CSZ built up strain before releasing it as fault slip during great earthquakes.

Dr. Kelin Wang of the Canadian Geological Survey, a leading expert on subduction zone fault modeling, produced hypothetical CSZ earthquake deformations that fit these geologic data as well as a wealth of new data on the temperature and shape of the subduction zone. Results of the first pilot project were summarized in DOGAMI Special Paper 41, which made clear that the

10,000-year geologic record is consistent with much wider range of CSZ earthquake and tsunami sizes than was considered in earlier work by DOGAMI and other scientists.

The March 11, 2011 Japanese earthquake is a reminder that ignorance of the full geologic record of local tsunami and earthquake size can lead to disastrous underestimation of the hazard. The second project, led by Dr. Witter, centered on the Bandon area where Bradley Lake held a 7,300-year record of CSZ tsunami deposits. Again, minimum offshore slip to get these deposits into the lake provided another test of the minimum size CSZ tsunami sources but now in southern Oregon where the geology is quite different from Cannon Beach. After both projects were completed, Dr. Witter and coauthors summarized findings in DOGAMI Special Paper 43, which laid out a series of CSZ, and maximum-considered distant tsunami scenarios appropriate for tsunami inundation mapping of the Oregon Coast.

CSZ scenarios finally selected for depiction on published tsunami inundation maps (TIM's) were labeled with "T-shirt" sizes S, M, L, XL, and XXL. The two maximum considered distant tsunami scenarios shown on TIM's are a historical maximum that occurred in 1964 (AK64) and a hypothetical maximum (AKMax) with higher uplift and more efficient focusing of tsunami energy at the Oregon coast than in 1964.

Tsunami evacuation maps depict a maximum considered distant tsunami inundation zone (AKMax) and a local tsunami evacuation zone (XXL). Final hydrodynamic simulations of the seven tsunami scenarios by Dr. Y. Joseph Zhang of OHSU (now of Virginia Tech) benefited greatly from the DOGAMI-led acquisition of lidar for the entire Oregon coast. Dr. Zhang's tsunami model, SELFE, unlike most other models is able to vary smoothly its computational grid size to take advantage of these detailed lidar data where they depict features like jetties and breakwaters that are critical tsunami controls. The result is state-of-art tsunami inundation maps and accompanying digital data that can be used for emergency management, land use planning, and engineering.

Due to these changes, the DOGAMI convened an advisory committee to review the current science and to recommend what, if any, changes needed to be made to the SB 379 line. The committee concluded that given changes in the science of tsunami inundation modeling and lidar-derived elevation maps, the current SB 379 line and maps no longer meet the needs of coastal communities and should be replaced. In addition, the committee recommended that the DOGAMI Board consider adopting the "large" scenario earthquake event, and the associated inundation zone, as identified on the new DOGAMI Tsunami Inundation Maps. The DOGAMI Board will be considering these recommendations on September 26, 2013.

DOGAMI-DLCD Coordination – Implications for land use planning of new tsunami inundation maps for the Oregon coast

Over the last few years, DOGAMI and DLCD met on a number of occasions to discuss the implications of new tsunami inundation maps produced for the 2009-2013 grant from the National Tsunami Hazard Mitigation Program (NTHMP) (administered by NOAA). In the meetings, illustration of, and the scientific basis for, the new inundation scenarios were presented by DOGAMI to inform a discussion of land use planning and emergency management issues.

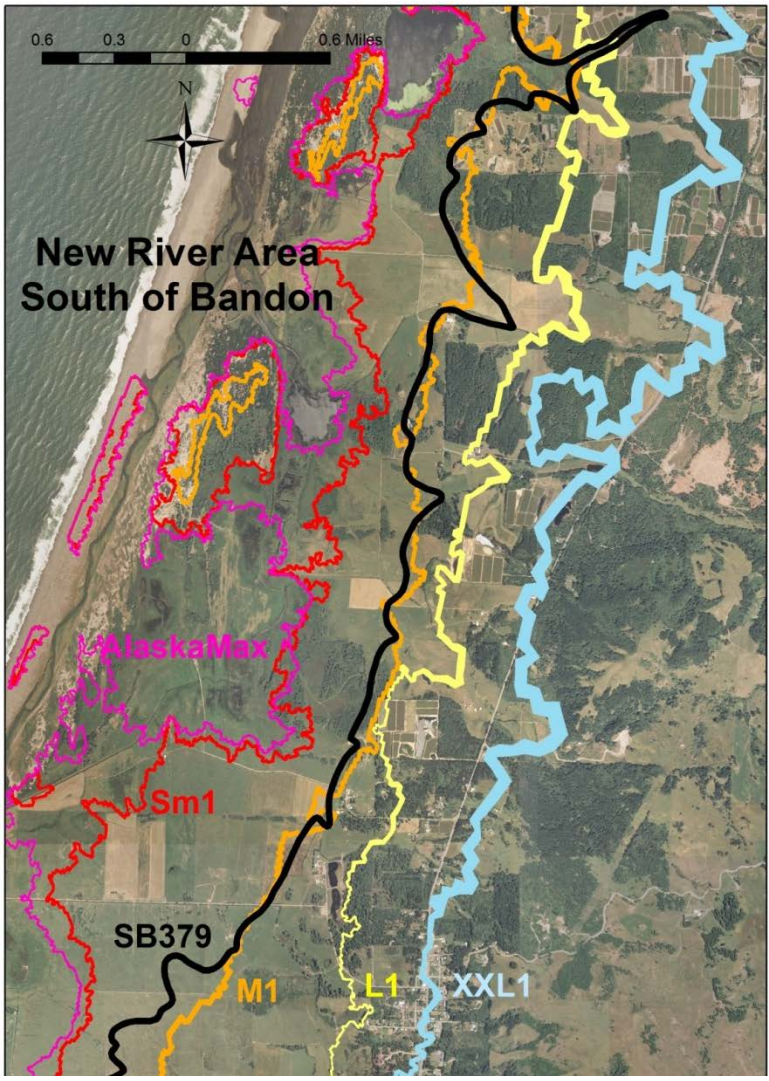


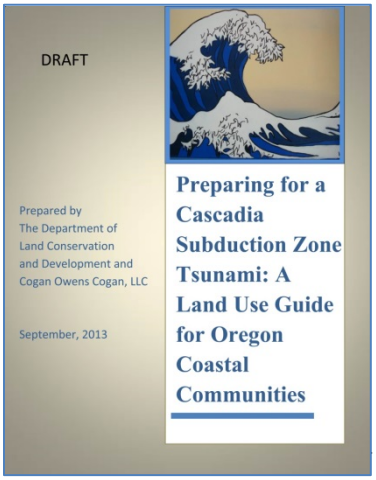
Figure 1 Comparison of currently adopted inundation tsunami zone (SB 379) with new mapping for potential tsunamis from a Cascadia subduction zone mega-thrust earthquake (Sm1, M1, L1, and XXL1) and a distant tsunami (AlaskaMax)

DLCD Land Use Guide for tsunami resilience

DLCD is currently developing guidance to assist vulnerable communities as they incorporate tsunami resilience into their local land use programs. The land use guide is designed to be tailored by communities to address their individual needs and risk tolerance. It will include sample comprehensive plan text, sample development code text, guidance on resilience financing, incentive concepts, tsunami evacuation planning guidance, and pre-disaster community land use planning.

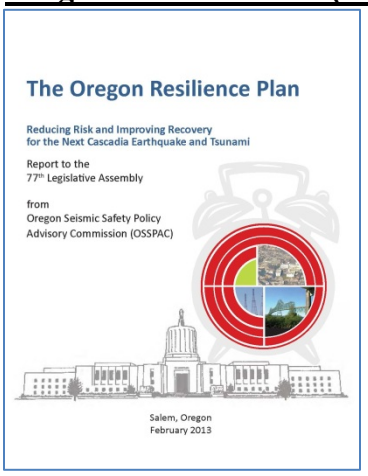
The guide will focus on integrating evacuation routes into the comprehensive plan and development regulations, limiting uses in hazardous areas, and providing incentives for development which reduces risk and increases resiliency.

There are three reasons for developing the guide at this time. First, it is consistent with federal coastal management priorities that emphasize helping communities address coastal hazards through land use planning. Second, the DOGAMI Tsunami Inundation Maps (TIMs) were completed in June of this year, and communities need assistance in how to apply them locally. Third, the Oregon Resilience Plan identified land use planning strategies



as key components to resilience. The target completion date for the Land Use Guide is January 2014.

Oregon Resilience Plan (OSSPAC)



House Resolution 3, adopted in April 2011, directed the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) to help Oregonians know what to expect from the state's infrastructure should a Cascadia disaster strike this year, and to propose the level of infrastructure reliability that a resilient state should provide. The plan's recommendations – the *Oregon Resilience Plan* - highlight ways to close the gap that separates expected and desired performance - mapping a path of policy and investment priorities for the next fifty years.

Eight Work Groups were charged with three primary tasks: First, determine the likely impact of the scenario earthquake on the assigned sector and estimate the time required to restore functions in that sector if the earthquake were to happen under current conditions. Second, define performance targets for each sector. The targets represent the desired timeframes to achieve resiliency. Finally, provide a series of recommendations to OSSPAC for changes in practice and policy that, if implemented, would ensure that Oregon reaches the desired resilience targets over the next 50 years.

Some OSSPAC recommendations included: comprehensive assessments; charging the Oregon Public Utility Commission to define criteria for seismic vulnerability assessments; completing a statewide inventory of critical buildings; updating inventories of local assets; launching a sustained program of capital investment in Oregon's public structures, including fully funding Oregon's Seismic Rehabilitation Grants; seismically upgrading lifeline transportation routes; establishing a State Resilience Office; and updating Oregon's public policies, including revising individual preparedness from the old standard of 72 hours to a minimum of two weeks.

Because the coast will suffer the worst consequences of this catastrophe, overall recommendations for coastal communities emphasize the following main actions in the next 50 years: consistent and relentless education; investing in hazard mitigation; strengthening critical facilities; and planning for reconstruction and recovery must be done now to provide a strategic vision for restoring the economy and livability of the Oregon coast.

SB33, passed in June, establishes the Task Force on Resilience Planning. The task force is made up of two members of the Oregon Senate, two members of the Oregon House of Representatives, eight members appointed by the Governor, the Director of the Office of Emergency Management or appointee, the chair of OSSPAC, The Director of Transportation or appointee,

and the Public Health Director or appointee. The task force is required to facilitate a comprehensive and robust plan to implement the strategic vision and roadmap of the Oregon Resilience Plan for responding to the consequences of naturally occurring seismic events associated with geologic shift along the Cascadia subduction zone. The task force must report to the legislature by October 1, 2014.

Floodplains

This report addresses two broad topics:

- National Flood Insurance Program
- Floodplain Mapping

National Flood Insurance Program (NFIP)

1. What is the NFIP?

   The National Flood Insurance Program (NFIP) was created by Congress in 1968 to minimize rising disaster relief costs to reduce the loss of life and property caused by flooding. The program has four goals: 1) provide affordable flood insurance, 2) stimulate local floodplain management, 3) emphasize less costly nonstructural flood control regulatory measures, and 4) reduce federal disaster costs by shifting the burden from taxpayers to floodplain occupants. The NFIP federally codified the concept of floodplain management and demonstrates a shift in flood damage avoidance measures from keeping water away from people, to keeping people away from water.

   If a local community participates in the NFIP, then residents and property owners can purchase flood insurance through the NFIP. Participation in the NFIP is voluntary. To participate, a community must adopt and enforce a floodplain management ordinance that regulates floodplain development according to NFIP standards. In Oregon, all counties participate and nearly all cities with floodplains participate.

   A Flood Insurance Study (FIS) is conducted by FEMA to determine the flood hazard present in a community as well as flood zones that will be used to write flood insurance. Data in the FIS is used to produce flood maps called Flood Insurance Rate Maps (FIRMS). FIRMS are the basis for implementing floodplain regulations and are adopted by local government.

Figure 1. The electric meter and heat pumps are elevated above the base flood elevation to comply with a local floodplain ordinance that was adopted as part of participating in the NFIP.

   FIRMS show areas with at least a 1% chance of flooding each year as the Special Flood Hazard Area (SFHA). These areas are sometimes called the 100 year floodplain, but we avoid that term because it gives the impression that it will be 100 years until the next flood. Some areas within the SFHA are closer to the river and have a much higher risk of flooding each year, but FIRMS do not distinguish the different probabilities within the SFHA. FIRMs often indicate how high flood waters are expected to be if the 1% flood occurs. This is called the Base Flood Elevation (BFE) and is used to regulate development. In an actual flood, waters can be higher or lower than the BFE. Homeowners within the SFHA are required to have insurance if they have a mortgage from a federally backed financial institution (which is nearly all mortgages). Homeowners within the SFHA who do not have a mortgage have the option to purchase flood insurance, and we strongly encourage that they do. Even homeowners outside the SFHA area can purchase flood insurance (at very reasonable rates). A recent study showed that less than 20% of the homeowners who are required to have flood insurance actually had insurance.

2. DLCD Role as State Floodplain Coordinator

Each state designates a state agency to as the coordinator to guide and enhance local government capabilities to meet NFIP standards. In Oregon, DLCD has been designated. The duties include:

2.1. Technical Support & Training

NFIP rules and standards are complex, and exact. The consequences of errors can be costly to building owners and can put a city or county's floodplain management program in jeopardy. DLCD regularly offers training and technical support to Oregon's floodplain managers and the professionals that support them (surveyors, builders, developers, real estate agents, building officials, etc.).

2.2. Floodplain Mapping Assistance

DLCD and DOGAMI both assist local government with accessing the most reliable flood hazard information available, and offer assistance when errors are found in official information, particularly in FIRMs.

2.3. Program Compliance Monitoring

The NFIP requires that local program compliance be monitored. DLCD is required to conduct compliance reviews under the terms of our grant agreement with FEMA. These Community Assistance Contacts and Community Assistance Visits are structured conversations and site visits, respectively, designed to help DLCD assess local implementation of NFIP development and construction standards. Local programs are required to be modified where deficiencies are found. In these instances, DLCD develops and monitors NFIP compliance plans.

2.4. Post-flood planning support & technical assistance

DLCD is a member of the Oregon Emergency Response System, the group of state agencies called to assist during natural hazard events. DLCD mostly provides technical assistance during flood events. Land use questions may arise, however, from other natural hazard events. In addition, agency resources, such as administrative support or GIS capabilities, may be called upon to support response or recovery.

3. Endangered Species Act (ESA)

FEMA was sued by environmentalists alleging that the NFIP has a negative effect on salmon species that are protected under the ESA because the availability of insurance increases development along rivers. As a result FEMA entered into consultation with the National Marine Fisheries Service (NMFS) as required by the ESA whenever federal agencies operate programs that could support or hinder recovery of threatened and endangered species. That process lead to NMFS issuing a biological opinion covering the NFIP in the State of Washington and changes in how FEMA administers the NFIP in Washington. The new procedures were very difficult for local governments to implement, and environmental groups found them to be so ineffective that they filed a second lawsuit. NMFS and FEMA are still in consultation about the NFIP in Oregon, and NMFS has not yet issued a biological opinion covering Oregon. DLCD has been involved to help guide the process to a solution that local governments can implement and that will be effective at protecting endangered salmon. Staff has provided FEMA and NMFS with information on Oregon's land use program and data available from DOGAMI. Staff has also worked to engage city and county planners and engineers on the issue. Successful implementation will likely require more precise mapping of flood hazard areas, a better understanding of channel migration zones, and analysis of areas within a floodplain that are become part of the stream channel during moderate flow conditions. DOGAMI will be an important source for data and analysis on these topics.

4. Base Flood Elevations (BFE) Determinations

Large areas along rural and moderately populated rivers are mapped within the special flood hazard areas, but for most of these areas FEMA has not defined a base flood elevation (BFE) to which the local community can regulate. Flood hazard mapping in rural areas is notoriously inaccurate and residents often have good cause to petition FEMA to be removed from the flood zone and mandatory flood insurance requirement. However, without a BFE residents have no flood elevation to prove their property is above base flood levels and find themselves stuck paying flood insurance.

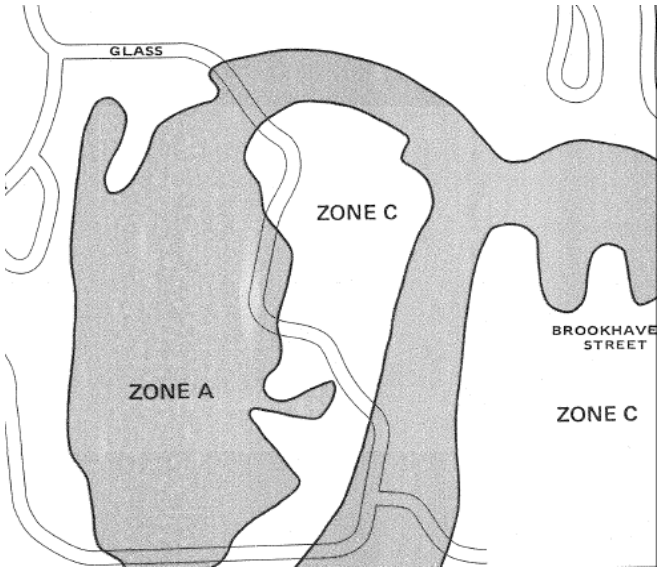


Figure 2. A flood insurance rate map (FIRM) showing floodplains (Zone A) without base flood elevations

Through its partnership with FEMA to update flood hazard mapping in Oregon, DOGAMI has developed an approved method to determine BFEs in these areas. At the request of DLCD, DOGAMI is exploring the potential for providing a BFE determination service and has initiated a pilot project.

What Works

DLCD receives numerous requests for BFE determinations. If the BFE determination service is deemed viable, it will fill a currently unmet need for provide property owners and communities throughout rural Oregon.

Challenges

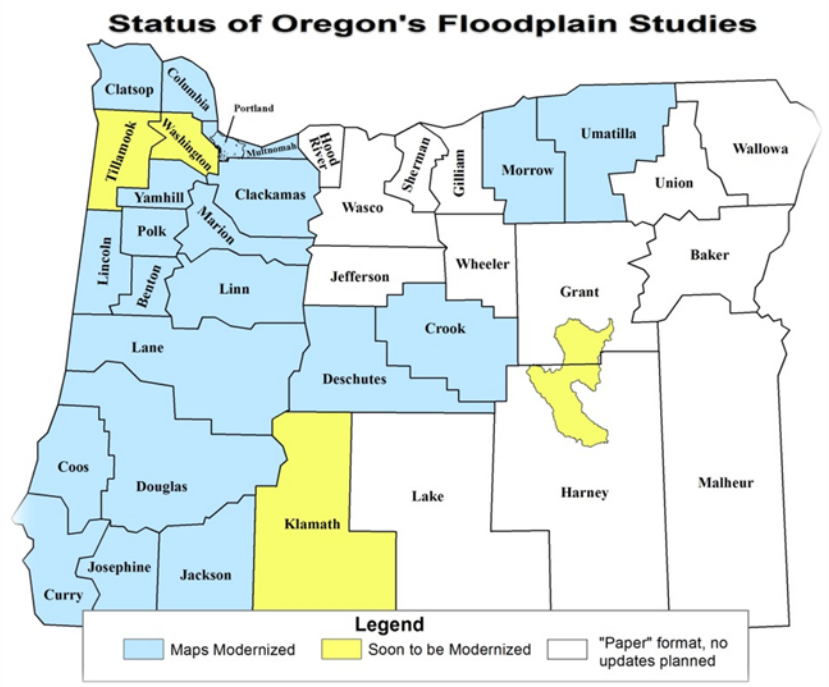
There remain uncertainties about the cost of a BFE determination service and the best way to distribute the data publicly. The pilot project aims to answer these questions.

Future Collaboration

DLCD will continue to send interested communities to DOGAMI. DOGAMI will work with DLCD to develop a brochure describing the BFE determination service.

Floodplain Mapping and Risk MAP

FEMA's Risk MAP (Mapping, Assessment, and Planning) is a 5-year initiative that builds on the recently completed Map Modernization program that updated and put in digital format much of the State's floodplain maps. Risk MAP has a broader and more holistic approach than Map Modernization, emphasizing not



just the delivery of accurate maps but working with communities to understand the causes of flooding and help with mitigation strategies. Oregon's expression of Risk MAP continues to underscore the Mapping, Assessment and Planning perspective of the "MAP" acronym, emphasizing the synergy of high-quality mapping with relationships among federal and state agencies and community partners. Integral to effective natural hazards planning are the ideas of: 1) "resilience" and "recovery"; 2) discussions on how to make State Land Use Goal 7 more relevant (while addressing community needs); and 3) addressing planning and mitigation opportunities. Risk MAP will continue to focus on unifying hazard information systems and efforts, building coalitions, and prioritizing areas in need of new Flood insurance Studies (FIS) – especially much of Eastern Oregon that remains in decades-old paper format.

Figure 3. Discovery meeting in Rockaway Beach, 2010.

5. Discovery Process

Prior to performing a new FIS for high priority locales, DOGAMI and DLCD meet with community officials to learn about problems with existing flood hazard maps. Detailed information is captured about past flood events, flood losses, existing hydraulic infrastructure, and planned projects in the floodplain. Information gathered is used to develop a needs assessment and initial project scope. DOGAMI and DLCD take this opportunity to also educate community officials on the technical aspects of flood studies, flood insurance implications, and mitigation strategies.

What Works

DOGAMI and DLCD are natural partners for the Risk MAP Discovery Process. Through existing relationships, DLCD connects DOGAMI with floodplain managers for each community. DOGAMI then facilitates Discovery meetings, focusing on FIS issues. DLCD in turn guides the community toward NFIP administration issues that will result from the new FIS.

Availability of lidar is required for updating flood hazard mapping and is therefore a major component of Risk MAP. DOGAMI's management of the statewide lidar program allows DLCD to easily learn where lidar exists or is planned. Future project collaboration opportunities exist between DOGAMI and DLCD as new lidar project areas become identified.

Challenges

Setting accurate expectations is a challenge due to budget limitations, unknown flood study results, and complexity of the NFIP and flood studies.

Future Collaboration

The Risk MAP Discovery process could serve as a model for regular check-ins with communities throughout the state to verify flood hazard information and mitigation strategies are up-to-date. With more state funding, DOGAMI and DLCD could enhance capacity and target communities with demonstrated need, rather than relying on FEMA metrics.

6. Flood Insurance Study (FIS)

After the Discovery phase, DOGAMI works with DLCD and communities to finalize the scope of the FIS. An FIS can be approximate or detailed. Approximate studies involve little or no fieldwork and BFEs are not determined. Detailed studies use considerably more specific hydrologic and hydraulic engineering methods; involve field work; and compute BFEs. Whether an area undergoes an approximate or detailed study is determined by the quality of

local data available. For example, a densely populated community with lidar will undergo a detailed FIS, while only an approximate FIS will be created for a rural town without lidar or other specific hydrologic and hydraulic data.

DOGAMI continues its coordination with DLCD throughout the life of the study. Draft study results are provided to DLCD so significant changes to flood hazard maps are understood and communication strategies can be developed. Upon completion of the FIS, the following steps are taken to adopt a new FIRM based on the new FIS:

1. Draft FIS and FIRM are delivered to and reviewed by FEMA
2. Preliminary FIS and FIRM delivered to local community
3. Final Coordination Meeting with local community, FEMA, study contractor and the public
4. Notice of Start of Appeals period in local newspaper
5. 90-Day Appeals Period
6. Appeals adjudicated
7. Letter of Final Determination Review sent to communities *(FIRMs will be effective in 6 months)*
8. Six-month period for local amendment of floodplain ordinance to reflect new maps. Local flood hazard development codes are also reviewed and, if necessary, updated.
9. Final "Official" FIS and FIRMs delivered to community

7. Mitigation Planning

Risk Assessments

With the FIS completed and FIRMs updated, DOGAMI uses data on buildings and infrastructure to assess risk at the community level. Exposure and expected economic loss are calculated at the building level for a variety of flood scenarios.

Areas of mitigation interest identified during the Discovery process are examined using the new flood hazard mapping to make informed recommendations on future mitigation actions.

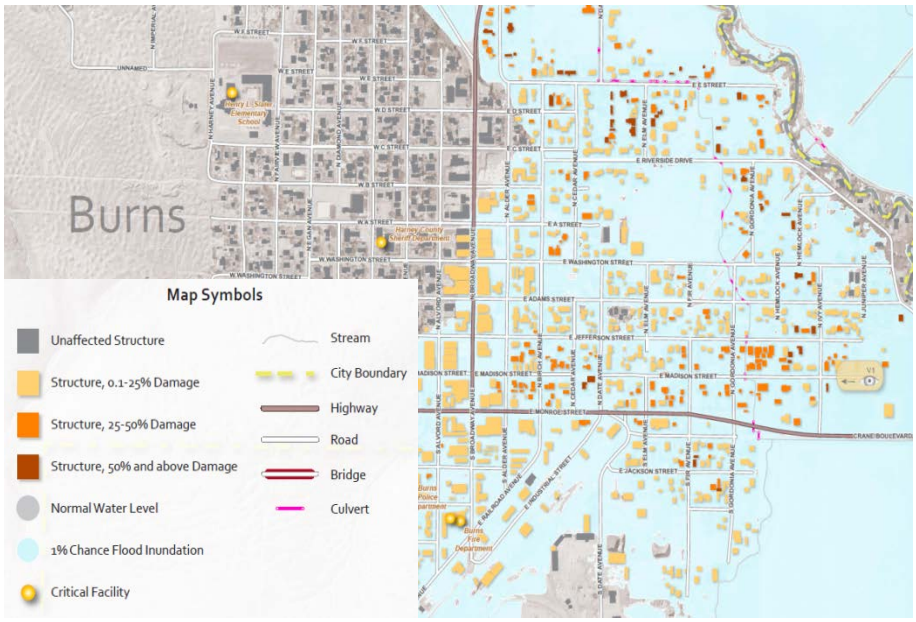


Figure 4. Example of loss estimation and exposure analysis.

Plan & Ordinance Updates

DLCD and DOGAMI work with communities to incorporate new flood hazard mapping and risk assessments into local natural hazard mitigation plan updates.

What Works

Many communities are working with flood hazard maps that are out of date by thirty or more years. Mapping technology has improved vastly over that period and the precision now afforded can help communities make better informed decisions about floodplain management. Data generated by DOGAMI is shared with DLCD to help cities and counties understand their flood risk, identify potential mitigation activities and steer new development away from hazardous areas.

Challenges

It is difficult to get communities to think about long-term mitigation strategies when changes to FEMA's regulated flood zone dominate the conversation. Flood insurance can be a crippling cost in many communities and the "in-or-out" of the SFHA approach taken by the NFIP does not aid communities in understanding actual risk. In addition, much of Eastern Oregon remains in paper format, with some mapping and flood studies not updated for over 30 years. FEMA funding for new studies has been significantly reduced for the foreseeable future; non-FEMA sources for floodplain mapping is needed if these lower populated areas are to be addressed.

Future Collaboration

With the recent NFIP reform, it will become more important for DOGAMI and DLCD to pool resources in an effort to help communities understand their options and get updated flood hazard mapping and risk assessments. Our mutual understanding of flood risk and effective risk communication strategies can help citizens move through the complex set of emotions that accompany introduction of new hazard information and maps.

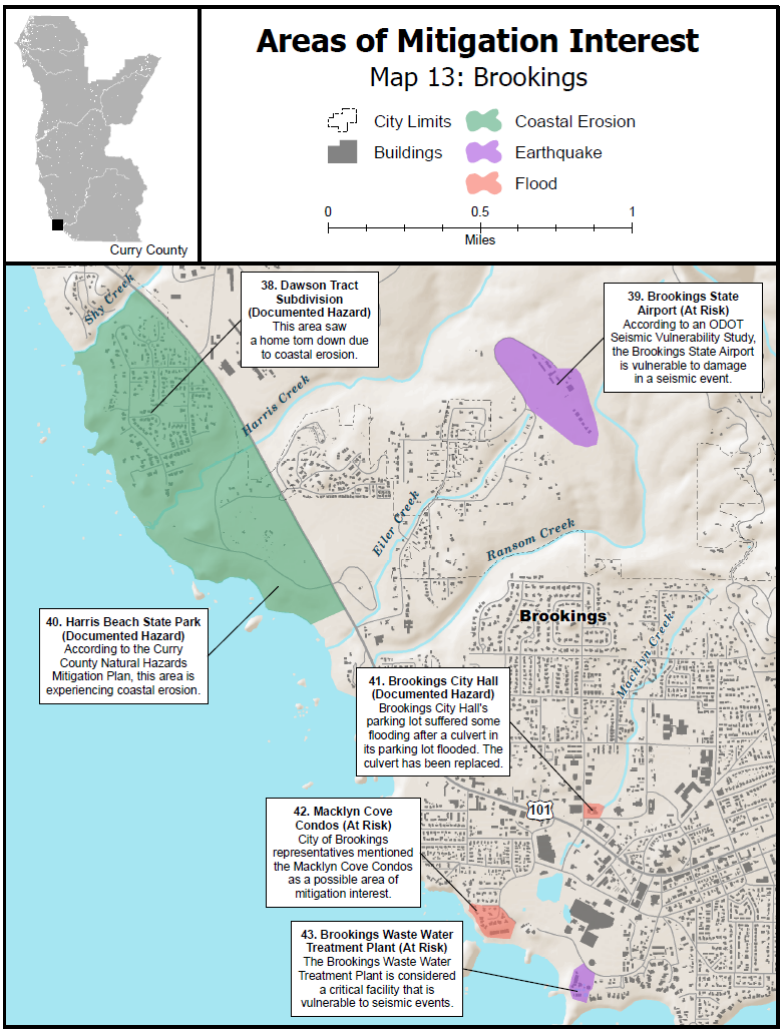


Figure 5. Example map of Areas of Mitigation Interest

8. Ongoing Coordination

Development of Statewide Flood Hazard Database

The Department of Administrative Services Geospatial Enterprise Office has funded DOGAMI over the 2013-2015 biennium to produce a statewide flood hazard database. DOGAMI will be working with DLCD to develop database specifications and a stewardship plan. The database will host all available flood study information for Oregon, high water marks, stream gage locations and much more.

State & Federal Coordination: Silver Jackets

DLCD and DOGAMI have strong roles in the Flood Subcommittee of the Interagency Hazard Mitigation Team, also known as the Silver Jackets. The subcommittee meets every two months with participants from the U.S. Army Corps of Engineers, FEMA, National Weather Service, U.S. Geological Survey, Oregon Water Resources Department and Oregon Emergency Management. The subcommittee focuses on cross-agency coordination on projects, perishable data capture during flood events and post-flood communication strategies. DOGAMI and DLCD will also be working with the subcommittee throughout the development of the statewide flood hazard database.

What Works

Participation with Silver Jackets has allowed DOGAMI and DLCD to work constructively with state and federal partners toward improving flood hazard data and achieving more efficient post-event coordination.

Challenges

Development of specifications for the statewide flood hazard database will require diligence, attention to detail, and great communication in order to lay out a plan for a truly useful tool.

Future Collaboration

Completion of the statewide flood hazard database will allow DOGAMI and DLCD to work from a common data source when addressing floodplain management issues. Continuing participation with Silver Jackets opens the door for new federal funding opportunities and project collaboration.

State and Local Hazard Mitigation

Background

Disasters occur as an interaction among three broad systems: natural systems, the built environment, and social systems. It is impossible to predict exactly when natural disaster will occur, or the extent to which they will affect communities within the state. However, with careful planning and collaboration, it is possible to minimize the losses that can occur from natural hazards. Oregon's State Natural Hazard Mitigation Plan (SHMP) is the vehicle for that planning and collaboration.

Natural hazard mitigation is the combination of short- and long-term actions taken to reduce or eliminate risk of damage to life, property, and resources from natural hazards. Engaging in mitigation activities provides the state with a number of benefits, including reduced loss of life, property, essential services, critical facilities, and economic hardship, and reduced short-term and long-term recovery and reconstruction costs. Oregon's SHMP identifies and prioritizes potential actions for reducing risk of damage from the State's eleven natural hazards: coastal erosion, drought, dust storms, earthquakes, fire, flood, landslide and debris flows, tsunamis, volcanic eruptions, windstorms, and winter storms.

State and local governments must have hazard mitigation plans in place as a prerequisite for certain hazard mitigation and disaster assistance. State and local natural hazard mitigation plans (LHMPs) must be updated every three years and five years, respectively. Oregon's first SHMP was completed in 1992; it was updated in 2000, 2004, 2006, 2009, and 2012. The current update got underway in March 2013 and must be completed by March 2, 2015.

Risk assessment and mitigation strategies are the principle components of the SHMP. The current risk assessment methodology is neither consistent across all hazards nor all scales, complicating identification and prioritization of target areas for hazard mitigation resources. In partnership with the University of Oregon InfoGraphics Lab, the Governor's State Interagency Hazard Mitigation Team (IHMT) has developed a concept for a new risk assessment methodology that would alleviate this issue, but funding to complete development of the model and begin implementation is unavailable at present. The SHMP's mitigation strategy prioritizes potential actions statewide intended to reduce vulnerability to natural hazards.

Plan Approval Process

The Federal Emergency Management Agency (FEMA) provides guidelines and has final approval authority for SHMPs and LHMPs. Oregon's SHMP is developed under the direction of the IHMT whose mission includes understanding losses arising from natural hazards and coordinating recommended strategies to mitigate loss of life, property, economic, and natural resources. The Office of Emergency Management is home to the State IHMT and its Chair, the State Hazard Mitigation Officer. Once approved by FEMA the SHMP becomes part of the State Emergency Management Plan. The process follows these steps:

1. IHMT staff review and revise the 2012 SHMP, creating the Draft 2015 SHMP.
2. IHMT reviews Draft 2015 SHMP.
3. IHMT staff revise the Draft 2015 SHMP as necessary in response to IHMT direction.
4. IHMT approves the Draft 2015 SHMP and submits it to FEMA for review.
5. IHMT staff revise the Draft 2015 SHMP as necessary based on FEMA direction.
6. IHMT approves the Final 2015 SHMP and resubmits for FEMA final approval.
7. FEMA gives "approval pending adoption."
8. Governor adopts Final 2015 SHMP by letter.
9. FEMA gives final approval.

Similarly, LHMPs are developed and adopted locally, reviewed by OEM, then submitted by the local government directly to FEMA for final approval. LHMPs may be individual, joint, or appended to the county's plan. All 36 of Oregon's counties have LHMPs. Of those, 75% are current; 25% will expire in 2014 or 2015.

DLCD/DOGAMI Collaboration: SHMP and Goal 7

DLCD has taken on management of the 2015 SHMP update. DOGAMI is a key partner in this effort, providing the current science and quality GIS data, analysis, products, and reports upon which much of the SHMP is based.

One of the requirements of SHMPs is coordination of hazard mitigation planning at the local and state levels. Another is providing funding and technical assistance to local governments for developing LHMPs. *Statewide Planning Goal 7: Areas Subject to Natural Hazards* also require state agencies to coordinate SHMPs and LHMPs and to provide local governments with hazard inventory information and technical assistance. SHMP and LHMP updates and Goal 7 implementation actions are interrelated and together present clear opportunities for coordination and collaboration; blending DOGAMI's scientific and DLCD's planning expertise.

Under Goal 7, when new hazard information becomes available and DLCD determines that a local response to the new information is necessary, the local government is to incorporate the

new information into its comprehensive plan policies and implementation measures. LHMPs are also incorporated into local comprehensive plans, usually by reference or as an appendix. Ideally, LHMPs would be fully integrated into comprehensive plans, and we are beginning to work toward that goal.

DOGAMI and DLCD have already begun to create opportunities for coordination and collaboration and to strategize about funding opportunities. These initiatives will pave the way forward for enhanced state and local hazard mitigation planning and implementation through SHMPs, LHMPs, and Goal 7 as well as continued interagency coordination and collaboration at a very high and consistent level.

Landslide Hazards

Background

Landslides are one of the most significant natural hazards in Oregon; they cause tens to hundreds of millions of dollars in losses annually and have caused a number of fatalities. In 1996-1997, several severe storms caused nearly 10,000 landslides in Oregon. At least 700 of these occurred in the Portland metropolitan region where over 100 homes were moderately damaged by or completely lost to landslides. The fatalities, number of landslides, and considerable damage and losses were a wake-up call that Oregon has significant landslide hazards and that we need to reduce landslide risk.

DOGAMI and DLCD have a long history of working together with communities in Oregon to reduce landslide risk. In 2012, Clackamas County contracted with DOGAMI to (1) develop shallow and deep landslide susceptibility maps for Clackamas County and 16 cities; (2) perform a risk analysis; and (3) provide technical support to the County and cities for integrating the mapped landslide information and risk analysis into the local Natural Hazard Mitigation Plans (LHMPs) and landslide hazard regulations.

DOGAMI's Role

Understanding the magnitude, frequency, and spatial distribution of areas where landslides have occurred in the past is a critical step in reducing landslide risk. The primary dataset used to create an inventory of landslides is lidar topography. To create a consistent landslide inventory for Oregon, DOGAMI developed and published a protocol entitled: Protocol for Inventory Mapping of Landslide Deposits from Light Detection and Ranging (lidar) Imagery (DOGAMI Special Paper 42). DOGAMI uses this protocol to create detailed Geographic Information System (GIS) datasets and maps. Once the comprehensive landslide inventory is complete, maps identifying susceptibility (or potential for future landslides) to the various types of future landslides can be created. DOGAMI followed this protocol to produce the landslide inventory maps for the Clackamas County project and used them to produce the shallow and deep landslide maps.

The hazard mapping is performed in cooperation with the local communities (city and/or county and/or state) to insure that they are aware of the forthcoming hazard data and allow the community to review and comment/edit the data. DOGAMI also compiles the landslide data into our Statewide Landslide Information Database (SLIDO) and puts the information onto the web in our interactive web map viewer at http://www.oregongeology.org/sub/slido/index.htm so that the public has access to the information.

Figure 1 shows an example of a suite of landslide hazard maps for Oregon City.

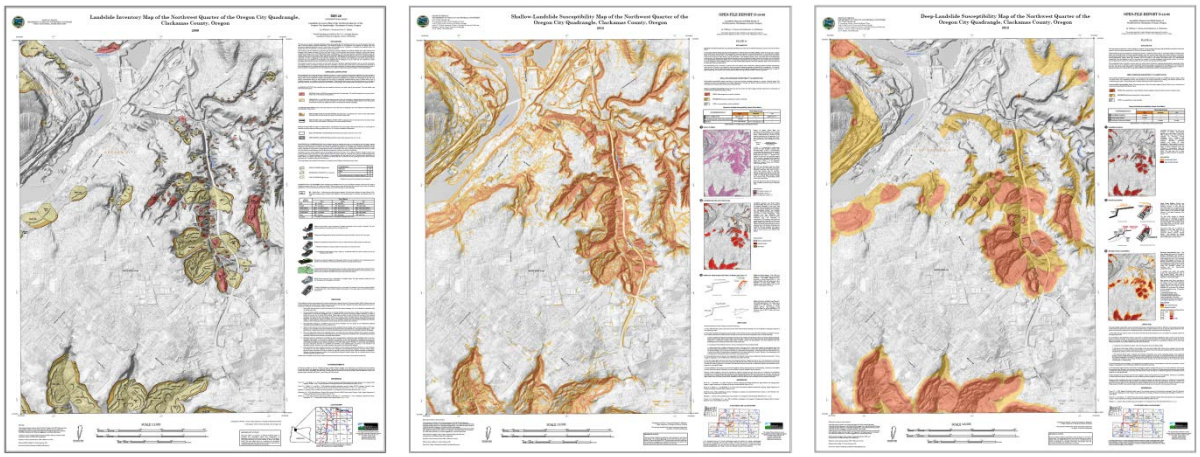


Figure 1. Landslide Inventory, Shallow landslide Susceptibility and Deep landslide Susceptibility maps of the City of Oregon City. Each map also comes with accompanying GIS data and detailed methodology and limitations.

DLCD's Role

Under Statewide Planning Goal 7, when DLCD receives new hazard inventories (for example, the new landslide maps from DOGAMI), the department must review the new information and consult with affected local governments to determine whether the information requires a local response. If it does, then the local governments are required to respond within three years. The local response must include evaluation of the risk, public involvement, and amendments to the comprehensive plan or development regulations.

As the first and second tasks of the Clackamas County project were nearing completion, DOGAMI invited DLCD to apply its planning expertise to the third task: assisting the County and cities with integrating this new information into local landslide hazard regulations. The information was integrated into the LHMPs early this year. DLCD and DOGAMI are now working together to develop a model code that local jurisdictions can use as they respond to the new information under the process in Goal 7.

This project presented an excellent opportunity to move Goal 7 implementation forward. In addition to promoting a close working relationship between the agencies, this project spurred discussion about the ways in which we can plan for and enhance future collaborations. For example, regular meetings to discuss projects and information help us prioritize and strategize hazard studies over the long term. Such meetings also promote collaboration on future grants or contracts from their inception, ensuring that both agencies' roles and work programs are coordinated.

Although this project is specific to landslide hazards, DLCD and DOGAMI envision employing this collaboration model for all the natural hazards DOGAMI studies.