SLOPE FAILURES IN OREGON

GIS INVENTORY FOR THREE 1996/97 STORM EVENTS

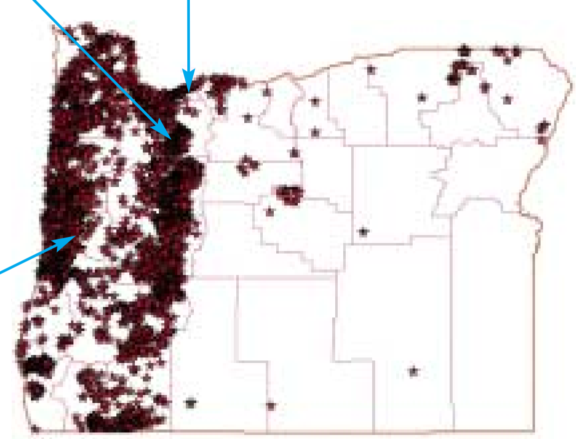
by

R. Jon Hofmeister

Oregon Department of Geology
and
Mineral Industries

Special Paper 34

2000



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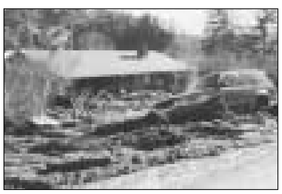
Cover illustration

The pictures show examples of landslides and the damage they can cause; the slides were part of the 9,582 slope failures reported for Oregon during three winter storm periods of 1996 and 1997 and included in the database of this report. Arrows show the approximate locations in western Oregon; unique identification numbers (Unique_ID) refer to the entries in this database:

Landslide scarp in Clackamas County, unique ID=1734
Photo by Jason Hinkle, Oregon Department of Forestry

This house was buried by rubble shown in the foreground that came out of the canyon visible in the background; Columbia River Gorge, Multnomah County, unique ID=2017
Photo by Kenneth Cruikshank, Portland State University



Landslide damage in Mapleton in the Coast Range of Lane County, unique ID=6401
Photo by John Seward, Oregon Department of Forestry

NOTE

The views and conclusions contained in this text and the database are those of the author and should not be construed as necessarily representing official state policies. The database is spatially variable and is dependent on original source contributions. No warranty for completeness, accuracy, or errors is expressed or implied.

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STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
John D. Beaulieu, State Geologist

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GIS Inventory for Three 1996/97 Storm Events

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ABSTRACT

The objective of this project was to collect and consolidate data on Oregon landslides associated with severe storm events in February 1996, November 1996, and December 1996 / January 1997. This study builds upon previous work in the Portland Metro area by Scott Burns and others at Portland State University, as well as on a number of other landslide studies throughout the state. The February storm event led to a Federal disaster declaration for 27 counties, the November event for 3, and the December / January storms for 14. Over 98 percent of the landslides were recorded in the western portion of the state, mainly in the Coast Range and the Cascade Range, with fewer in the Willamette Valley and the Klamath Mountains. Counties with the highest percentage of total landslides reported are Lane (24 %), Douglas (11 %), Linn (10 %), Clackamas (9 %), Tillamook (9 %), Lincoln (8 %), and Multnomah (7 %).

The products of this study are (1) a digital Geographic Information System (GIS) inventory of Oregon landslide locations, (2) a spreadsheet version of the inventory for those not using GIS, and (3) this explanatory text. The inventory database includes 9,582 slide location entries, with varying amounts of information reported for each individual entry. The database entries contain several items describing the geographic location of each landslide and up to 15 additional items relating to failure mechanism, size, geometry, associated damage, etc., depending upon the information obtained from the contributing sources. The digital outputs are intended to provide a starting point for future landslide-related studies.

INTRODUCTION

Nationwide, ground failures account for 25 to 50 deaths annually and approximately $1.5 billion in economic losses, more than all other natural disasters combined (Schuster, 1996). The Pacific Northwest, with its wet climate and considerable topographic relief, is one of the more prolific portions of the nation for slope failures. As Oregon’s population continues to increase, and as areas undergo development that previously had been considered unsafe for building, the problem is often exacerbated.

The impetus for developing this database was a desire to better document the magnitude and distribution of landslide occurrences throughout Oregon. Funding for the project was awarded to the Oregon Department of Geology and Minerals Industries (DOGAMI) through a competitive bidding process by the Federal Emergency Management Agency (FEMA). The resulting inventory provides both technical and nontechnical users with readily accessible data for exploring landslide issues. It is hoped that the data will lead to a greater understanding of regional landslide issues and assist in efforts to minimize the threat to public health and property that landslides can pose.

THE 1996 AND 1997 STORM EVENTS

The Oregon storm events of 1996 and early 1997 were particularly damaging. Three significant storms occurred during that time period, each causing widespread slope failures throughout Oregon. The three events occurred in February 1996, November 1996, and late December 1996 to early January 1997, and each received a Federal “major disaster” declaration. The February 1996 storm impacted most of the western and northern portions of the state. The November storm originated offshore and swept primarily through Coos, Douglas, and Lane Counties. The late 1996 and early 1997 storms heavily hit the southern portion of the state as well as the northeastern counties. Figures 1–3 show the Oregon counties included in the Federal disaster declarations for each of the three events. Each of these storms produced near record rainfall, which triggered extensive landslide activity throughout the impact areas.

The following synopses of the essential characteristics of each of the three storm events were provided by State Climatologist George H. Taylor, College of Oceanic and Atmospheric Sciences, Oregon State University. Other summaries of the nature of the storm events can be found in Robison and others (1999) and Wiley (2000).

> **February 1996**. This was a record-setting four-day rainfall event, preceded by a very cold period with subfreezing temperatures day and night. None of the individual days was a record-setter, but the four-day total surpassed previous records in much of Oregon (mostly in northwest Oregon, north of Eugene, and across the northern counties to northeast Oregon). The north coast of Oregon saw several all-time stream-flow records set.
>
> **November 1996**. This was perhaps Oregon’s greatest one-day rainfall event since record keeping began. The all-time one-day record for the state (11.65 inches) was set at Elk River Fish Hatchery near Port Orford. In addition, all-time one-day records were set at Roseburg, Corvallis, North Bend, Salem, and Redmond.
>
> **December 1996/January 1997**. This event was a series of storms that formed off the southern Oregon coast and moved slowly northward, bringing high winds as well as ample precipitation to an area from central California to Washington. (Taylor, written communication, 2000)

The damage to natural resources and infrastructure resulting from these three storm events was extreme. A preliminary estimate for the February 1996 event alone was $280 million in total damage (FEMA, 1996a). Landslides are not separated from total flood damage in this estimate, but the percentage directly related to slide activity is believed to be significant. In the Portland metropolitan region, for example, approximately 40 percent of the $10 million in infrastructure damage from the February 1996 storm is attributed to landslide phenomena (Burns, 1998).

Figure 1. Counties included in the Federal disaster declaration, February 1996 storm event. Adapted from FEMA (1996a).

Figure 2. Counties included in the Federal disaster declaration, November 1996 storm event. Adapted from FEMA (1997).

Figure 3. Counties included in the Federal disaster declaration, December 1996/January 1997 storm event. Adapted from FEMA (1997).

MINIMIZING LANDSLIDE HAZARDS

Landsliding is a gravity-driven process whereby earth materials move down a slope. The downslope movement may be triggered by a number of factors including earthquake shaking, volcanic eruption, blasting, wave or stream erosion, or intense rainfall. While the potential for a landslide generally increases with increasing slope angle, slope failures are a complex function of geometric, geologic, hydrologic, and other conditions (Turner and Schuster, 1996). Landslides often occur naturally, but slope movement can be exacerbated by development activities. Increased, rerouted or concentrated runoff, man-made cuts into hillsides, and the placement of nonengineered fill material can all lead to an increase in slope failures.

Whether in natural or altered slopes, earth movement can be destructive when people or structures are involved. Reducing the devastating impact that landslides have on our communities is a lofty goal and one well worth the time and effort. The evaluation of landslide risk on a regional scale involves a multi-faceted effort to characterize total landslide risk, assess feasibility of risk reduction techniques, and implement selected strategies.

This inventory addresses the regional distribution of slope instability statewide for the major 1996 and 1997 events. Slope failure inventories are critical for evaluating known hazards and applying the knowledge gained to reduce future risk. Previous failure is often a strong indication that an area may be unstable again in the future. Thus, the statewide database developed in this study provides a solid baseline for evaluating where problem areas and conditions exist. It can then serve as a basis for tracking additional landslide locations and future mitigation efforts.

DATA COLLECTION METHODS

The development of the landslide database was a consolidation effort. The extent and quality of the input was dependent on identifying and working with potential sources and compiling data within a short time frame. The primary data collection objectives were to (1) contact as many potential sources as possible, (2) minimize the time imposition on contributors, and (3) obtain as much useful information as possible in the short data collection time period.

Various methods were used to contact potential sources, inform them of the existence of the study, and request their participation. Materials including a project web site, a one-page data collection form, group mail and e-mail lists, and descriptive fliers were developed to facilitate widespread distribution of information to potential respondents. Extensive personal phone and e-mail contacts were also made with individual sources likely to have slide information.

Data collection required a careful balance between attempting to obtain as much information as possible and minimizing the time imposition on contributors. It was recognized that if the effort to respond was considered too extensive, potential sources would be unlikely to contribute any data. Thus a one-page data reporting form (Appendix A) was used to minimize the impact on contributors with smaller numbers of landslides to report. Contributors with previously compiled data were encouraged to submit those in their existing form, and the database was designed to accommodate a variety of formats.

In the effort to collect and compile a significant amount of useful information quickly, the larger jurisdictions were contacted first, followed by contacts at local levels. The initial contacts were federal and state agencies, including the National Forest System offices, the Federal Emergency Management Agency (FEMA), the Bureau of Land Management districts, the Oregon Department of Forestry (ODF) headquarters, the Oregon Department of Transportation (ODOT) regional offices, and Oregon Emergency Management (OEM). Each of these large public agencies had numerous landslides to incorporate.

Once a sufficient amount of base information was obtained from these agencies, the second stage of the database development focused on adding coverage at the county and city levels. In addition to a number of other public and private sources, each county and major metropolitan public works department was contacted. At the county level, the distribution of the base GIS from the larger public sources facilitated the incorporation of additional data. In many cases, local respondents were willing and able to mark slide locations on GIS-generated map layers that included roads and other recognizable features along with the landslide locations previously identified. Utilizing this procedure, knowledgeable local sources could both add to and comment on the locations obtained from the other sources. This approach saved time by avoiding repeat entries (although a few duplications may still exist) and also provided feedback on the data previously incorporated.

While as much information as possible was gathered within the timeline of the project, it was clear from the onset that not all information would be collected on all slides that occurred during the 1996 and 1997 time period. Several barriers prohibited obtaining comprehensive information. Many slides that occurred throughout the state were not recorded. Particularly in remote areas, slides were not catalogued comprehensively, and many were not even observed. Other slides that were observed, were not recorded if they did not impact infrastructure. And in some of the more heavily hit areas, there were simply too many slides to allow recording in a comprehensive manner. Fortunately, in some of these cases, useful information could be gleaned by utilizing the recall of knowledgeable local experts.

DATABASE CONTENTS

Despite the barriers to achieving exhaustive landslide coverage, a substantial amount of information was consolidated. The database contains a total of 9,582 landslide entries. As shown in Figure 4, most of the entries fall within the western portion of the state. There was some slide activity recorded in the north and northeast, but very few slides reported in the flatter, southeast portion of the state.

The level of detail incorporated into the database was dictated, in most cases, by what was previously gathered by individuals working throughout the state. As previously mentioned, the incoming data formats

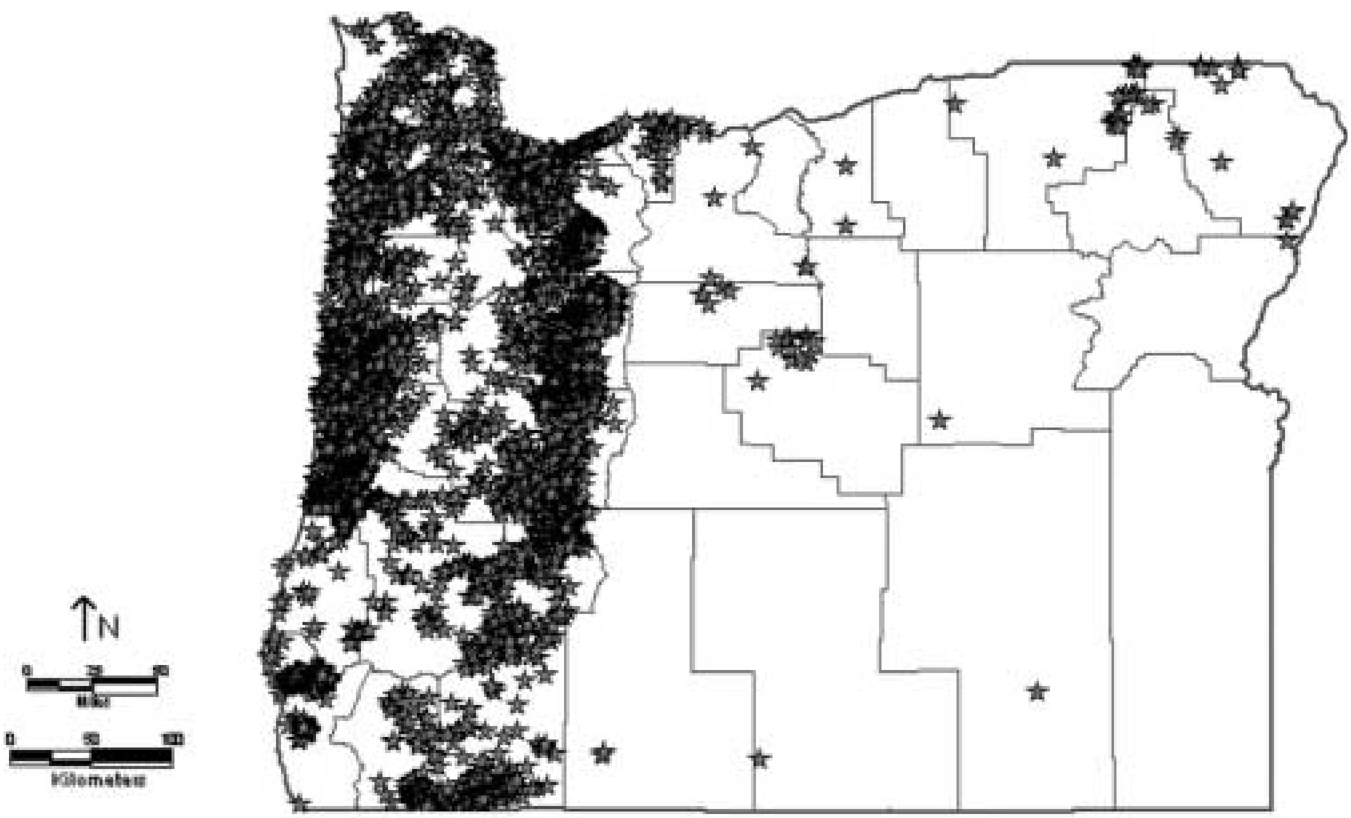

Figure 4. Distribution of database entries throughout the state.

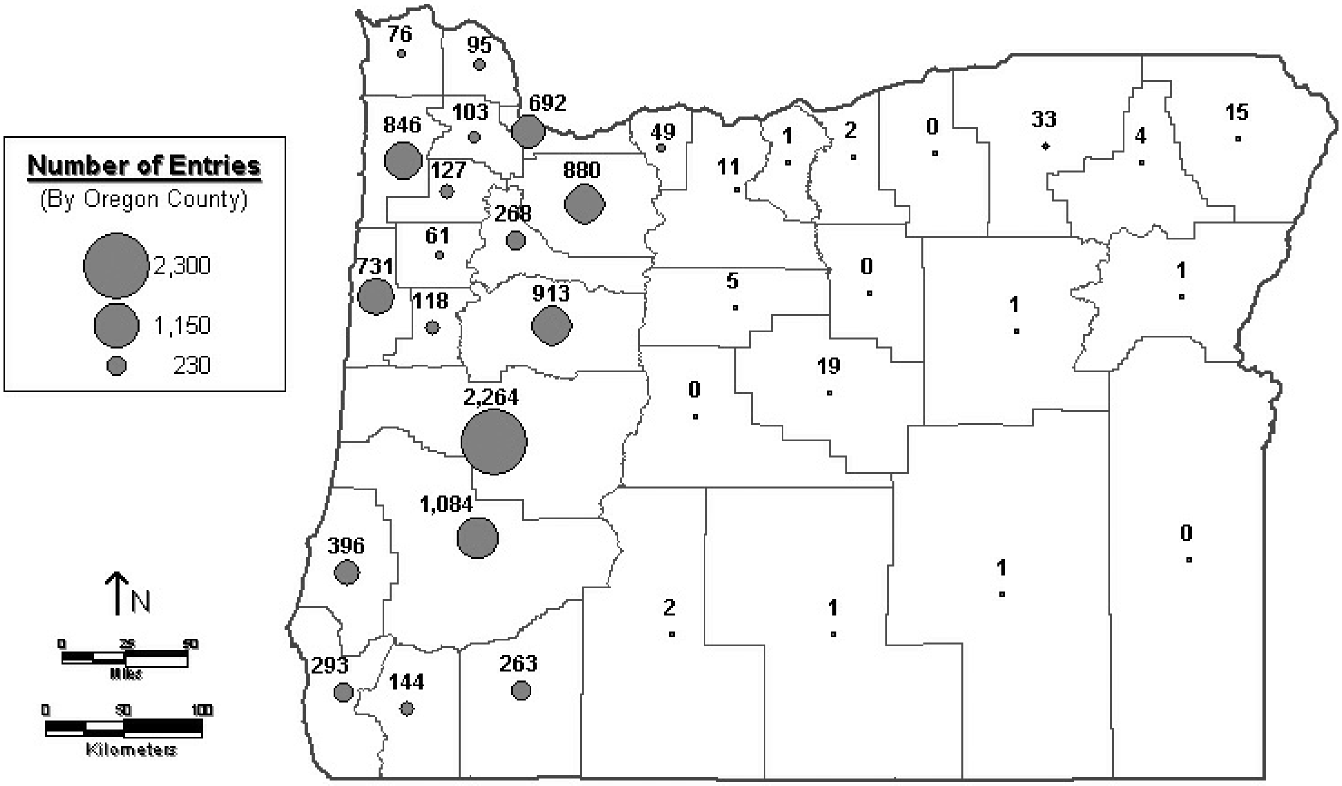

Figure 5. Number of database entries reported in each Oregon county.

varied a great deal, from paper copy reports to digital points and boundaries. With the goal being to gather as much useful information as possible, very little was rejected, and the database is structured to accommodate a range of inputs from as minimal as point locations with no associated information for some entries to extensively detailed data for others.

The definition of the term "landslide" used for the data collection was very broad and was governed more by practical considerations than technical distinctions. The database includes all reported ground failures, except a few determined to be solely due to flood-related erosion. While the focus was on gathering slide entries in Oregon associated with the three storm events, some slide incidences from other events and locations just outside the state border were submitted. Rather than to exclude this information, it was incorporated since it might be of some interest to users. Of the 9,582 entries included, 30 refer to slides that occurred in the Washington portion of the Umatilla National Forest, and 53 occurred in the California portion of the Rogue River National Forest. The remaining slide entries fall within the Oregon state boundaries.

It is noteworthy that such a large number of slides associated with these storms occurred statewide. Predictably, counties that were declared disaster areas had a large number of slides, but other counties also suffered widespread slope failure. Figure 5 provides a breakdown of the database entries per county. While the numbers do not fully reflect the portion of total slide activity associated with the counties,[1] the figure provides some indication of particularly heavily hit counties. Lane County had the largest number of incorporated slides with 2,264 (~24 percent), followed by Douglas County with 1,084 (~11 percent).

[1] The actual count is skewed by the type of studies conducted in the area and the amount of information contributed as discussed in the Limitations section.

DATABASE FORMAT

The output database is available in both GIS and spreadsheet formats on the accompanying compact disc (CD). The GIS files are separated into polygon, polyline, and point coverages that are available in both MapInfo (.tab) and ArcView Shape (.shp) file formats. The slide locations are stored as polygons, lines, or points (Figure 6), depending on the level of detail provided by the sources. For slide areas with well-defined boundaries, polygons were used. For linear features, such as debris flow paths and sections of roads impacted by slide activity, line features were used. For the vast majority of the slides, however, point locations were the best locators the data could support.

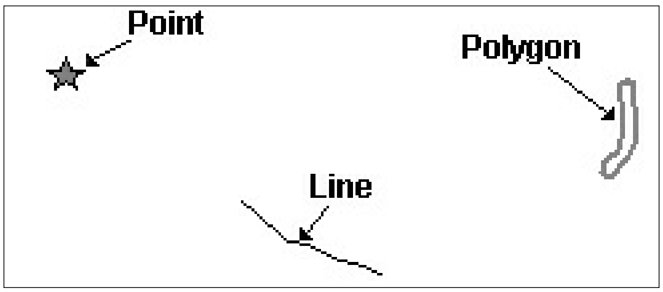

Figure 6: Schematic of GIS polygon, line, and point objects.

For those not using GIS, the coverage has been exported to spreadsheet formats including Microsoft Excel 2000 (.xls) and tab-delimited ASCII text (.txt). The attribute information is identical in the GIS coverages and the spreadsheet, but the best geographic references in the spreadsheet are point coordinates (longitude/latitude) and the other general geographic references listed below.

The fields of information associated with the landslide entries are summarized in full in Appendix C, Data Dictionary. Each entry in the database has the following set of common attributes associated with it:

- Unique_ID (Unique identifier ranging from 1 to 9582)
- Source_Nm (Name assigned to the source; sources are listed in Appendix B)
- Source_ID (Identifier assigned to the source data)
- TYPE (Type of GIS entry, either POINT, LINE, or POLY for polygon)
- LONG (Longitude of the GIS entry centroid in decimal degrees)
- LAT (Latitude of the GIS entry centroid in decimal degrees)
- COUNTY (county name added from a GIS overlay[2])
- USGS_QUAD (USGS 7.5-minute quad name from a GIS overlay[2])
- PLSS (Township, Range, and Section from a GIS overlay[2])
- PLSSnoDLC (Township, Range, and Section without Donation Land Claims[2])
- SUBBASIN (Watershed subbasin name from a GIS overlay[2])
- WATERSHED (Fifth-field watershed name from a GIS overlay[2])

These attributes are useful to those not using GIS for selecting individual source data sets and performing regional queries. The Source_Nm field contains the unique identifier selected for each contributing source. The source name identifiers are listed in Appendix B, along with current contact information. (If the need does arise to contact any of these agencies or individuals, please be respectful of their time. They have generously helped with this project on a voluntary basis and may or may not be able to contribute further.) The TYPE field designates whether the entry is stored as a point, line, or polygon. This is included primarily so that those not using GIS can determine how the spatial information is stored in the GIS. The LONG and LAT values were assigned within the GIS and refer to the centroid coordinates of the object. Therefore, for polygons and polylines, these longitude/latitude values are a gross simplification of the original object. The fields COUNTY, USGS_QUAD, PLSS, PLSSnoDLC, SUBBASIN, and WATERSHED were added using simple GIS overlay operations. The overlay files used to assign these geographic designations are listed in Appendix C, Data Dictionary. Because of the regional nature of both the inventory entries and the overlay files, entries along borders may not be correctly assigned. Consequently, when performing queries using these geographic descriptors where the objective is to cap-

[2] The GIS files used for the overlays are listed in Appendix C, Data Dictionary.

ture all potentially relevant entries, extending the search by one unit in each direction is recommended.

In addition to these general source and location attributes, the information from the data form in Appendix A, Landslide Inventory Data Sheet, was also included if provided or if it could be translated from original source data. Some of the database entries include all of the associated information for each landslide location, others very little. The "Count" listings in Appendix C, Data Dictionary, provide information on the extent to which each field is populated.

Some sources have specific reports and other associated items of information that may be of interest to some users. If additional data or summary reports are known to be available, a description and references are provided in the last field of the database, Additional_Info. The full citations for reports are provided at the end of this text.

LIMITATIONS

Much valuable information is included in the consolidated inventory, but not all of the data are appropriate for all applications. Both spatial accuracy and content vary considerably within the database. Some of the resulting limitations are specifically outlined in this section, and some suggestions for application of the data follow in a separate section.

Spatial accuracy

The spatial accuracy of the GIS polygons, lines, and points varies significantly from source to source, depending on the means of collecting and incorporating the location information. Examples of how entries were added to the GIS include digitizing marks noted on USGS 7.5-minute quadrangles and other base maps, importing source-provided coordinates, and determining polygon outlines from aerial photographs. Many of the locations are approximate and should be used only as a general reference. Some of the source reports included in the references provide greater detail on the accuracy and applicability of the particular data sets. This includes particularly Bush and others (1997), Stack (1997), Umatilla National Forest (1997), Burns and others (1998), Siskiyou National Forest (1998), Governor's Watershed Enhancement Board (GWEB, 1999), Lloyd (1999), Robison and others (1999), and Willamette National Forest (1999). The database also includes a "Source of Location" description for the entries, which provides some information on how they were located.

Data distribution

In addition to the variance in spatial accuracy, the distribution of the data is also highly variable, depending on the source. The regional distribution is governed not only by where the slides occurred but just as much, or more so, by who collected and provided information for each area. As noted earlier, the database does not include all landslides that occurred during the three storm events. Although a lot of information was received, it is still only a piece of the total picture. Some potential sources were unable to respond for various reasons. In some cases, even information that was gathered could not be included. For example, FEMA has detailed records for disaster-related projects funded by the agency, and a number of landslide projects are included. In some cases, however, the point locations in the database refer to multiple slides in a concentrated area. The FEMA portion of the database, therefore, is an example of a source that is not appropriate for counting slides or determining slide densities.

Specific focus

Most of the consolidated inventory is not appropriate for regional landslide density estimates due to specific focus regions for the study. Figure 7 illustrates this, showing a portion of the database in the Elk Creek watershed inventoried by the Oregon Department of Forestry (ODF). The ODF Storm Impacts Study (Robison and others, 1999) was one of the most extensive inventory efforts conducted following the storms. Note that within the ODF Elk Creek study area, a number of slides are recorded, whereas the bordering watersheds appear to have no slides. This is only an artifact of data availability, and does not reflect what actually occurred in the field.

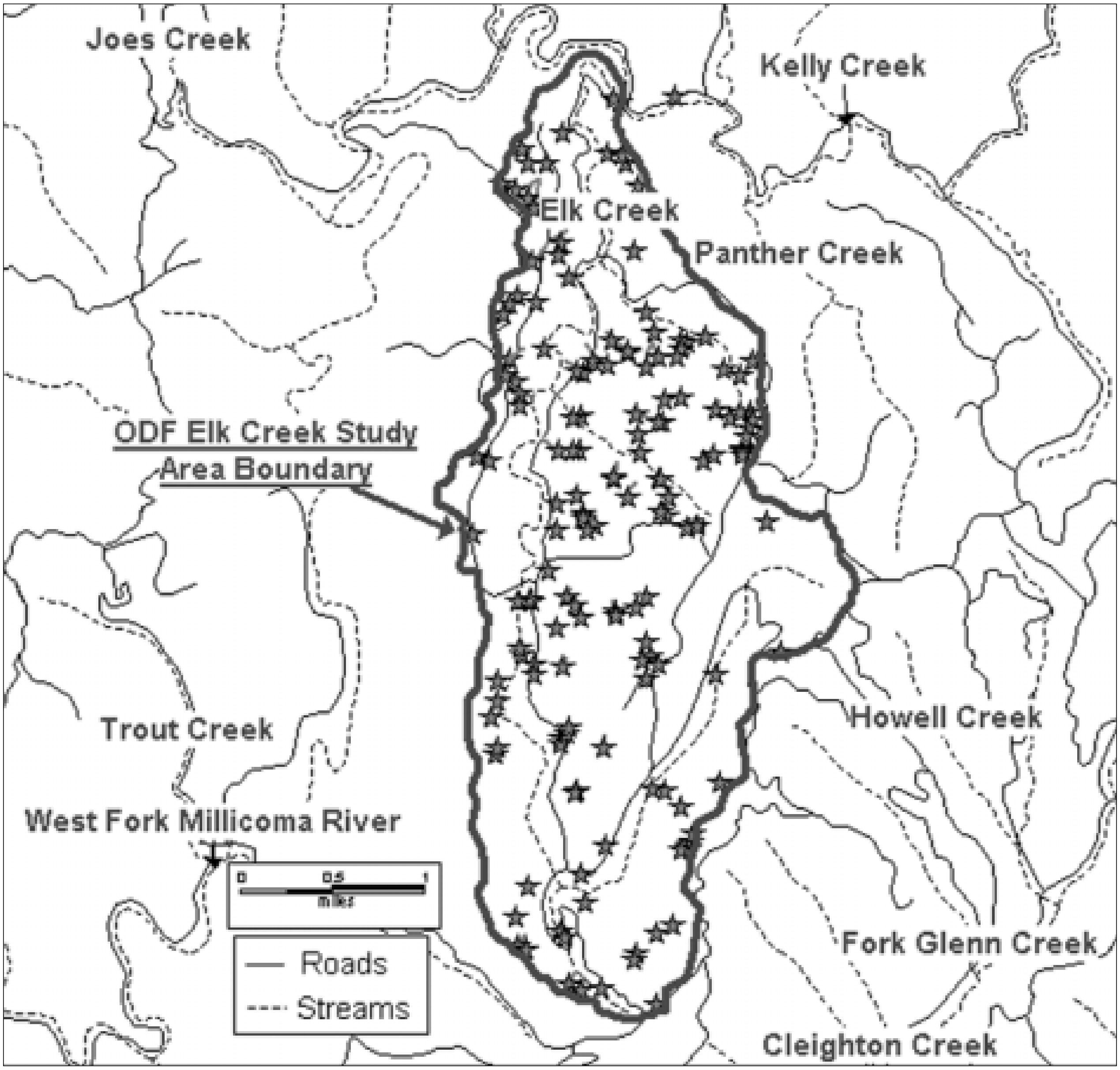

Figure 7. Illustration of break in the distribution of landslides as a result of the data collection boundary. This landslide inventory was conducted by the Oregon Department of Forestry after the 1996 storms and shows the Elk Creek watershed in Elliott State Forest, Coos County. After Robison and others (1999).

Some sources focused data collection efforts on particular types of slide activity. The Willamette National Forest, for example, developed an excellent inventory of debris flow occurrences (Lloyd, 1999). Smaller rotational and translational slides, however, were not necessarily included in this otherwise comprehensive database. Several other sources (ODOT, RogERFO, UmpERFO96, UmpERFO97, WillERFO, Gweb_rd, BLMEugene, and CtyLane) focused their inventory efforts on damage that affected roads.

Source data errors

The source databases were inspected for errors as they were submitted. In cases where errors were found, corrections were made by working with the contributing sources. Extensive verification and revisions of the original data have not, however, been performed. It is likely that some errors exist within the database, and some data verification is appropriate as part of follow-up studies that make use of the consolidated inventory.

POTENTIAL USES

Although the database is not adequate for most site-specific studies, it is a very useful tool for scientists, engineers, public officials, students, homeowners, and others who would like to know more about slide activity in Oregon. A few of the many foreseeable uses of the 1996 and 1997 landslide inventory are briefly described below.

Planning

Since landslides often recur in approximately the same locations, this snapshot can give planners insight into where problem areas exist and what may subsequently occur within their region of interest. While most planners are already familiar with their problem areas, the GIS inventory can also provide a convenient means for presenting current data and capturing additional information.

Regional analyses

Correlating slide occurrences with other physical parameters such as elevation, slope angle, geologic materials, rainfall intensity and / or vegetation is appropriate for some portions of the database. The limitations should be fully understood when interpreting such correlations, however. As outlined in the "Limitations" section, there may be skews in the database that are a function of the data collection procedure rather than real geographic variations. This negative effect may be minimized by selecting and using only regionally-consistent portions of the total data set.

Hazard map calibration

An important part of the hazard mapping process is to verify models using data on actual failures such as this inventory. For the generation of zonation maps, for example, it may be useful to compare the actual slide occurrences with hazard zone designations.

GIS baseline for additional inventory development

The database can serve as a means for refining and adding landslide information. Many counties are in early stages of development of their GIS systems. Rather than starting from scratch, it may be useful to build on and improve their landslide coverages using the database provided here.

FUTURE EFFORTS

One of the parallel objectives of this database development is to stimulate complementary inventory efforts. There is ample room for growth, both in terms of enhancing detail on this 1996 / 1997 inventory, as well as expanding the database to specifically include other storms and time periods. Several projects are currently under way which may provide a significant amount of useful information to broaden the coverage in the existing database. In particular, the Umpqua National Forest (Larry Broeker, personal communication, 1999) and the Oregon Department of Transportation (Jan Six, personal communication, 1999) are currently developing more comprehensive inventories.

It is hoped that future collaborative efforts between major local, state, and federal agencies will be organized. Developing consistent methods to track slide activity and setting up a central repository for landslide information would be two major steps toward developing a more comprehensive and useful database. Accomplishments to date, together with future enhancements, can lead to successes in minimizing and mitigating landslide-related threats to public safety and property in Oregon.

ACKNOWLEDGMENTS

Many organizations and individuals generously provided data for this consolidation effort. The willingness of researchers and practitioners throughout the state to take time out of their busy schedules to help with this project is a real tribute to the "landslide community" in Oregon. For each of you who contributed, I would like to extend a warm thank you — your willingness to help is greatly appreciated.

Valuable reviews of this report were provided by Gerald Black, Dennis Olmstead, and Yumei Wang of DOGAMI, Scott Burns of Portland State University, Courtney Cloyd of the USDA Siuslaw National Forest, Keith Mills of the Oregon Department of Forestry, and George Taylor of the Oregon Climate Service Center. Courtney Cloyd and Caroline Gordon of the USDA National Forest System, Don Wiley of the Hood River County Public Works Department, Marcia Malstrom of the Oregon Department of Transportation, and Mary D'Aversa of the U.S. Bureau of Land Management deserve special mention for being particularly helpful in the data collection process. Funding for this project was provided by the Oregon Department of Geology and Mineral Industries through FEMA under agreement number EMS-98-CA-0061.

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APPENDIX A. LANDSLIDE INVENTORY DATA SHEET

Oregon Department of Geology and Mineral Industries (DOGAMI)

Contact Information

Name: ________________________________ Phone Number: _________________________

Title: ________________________________ e-mail: _______________________________

Organization:____

___Yes, it is okay to include this contact information in the project report.

Landslide Characteristics

1. Landslide ID: ____________________ (corresponding to your own system)

2. Landslide Name (if any): ____

3. Location of Slide:

Coordinates (e.g., longitude/latitude): _______________________________

Source of Location (e.g,. field mapping on 1:24K quads.) or other (e.g., map attached, address, description): ____

____

4. Date(s) of Slide Activity (please check all that apply):

a. February '96 __ c. December-January '97 __

b. November '96 __ d. Other: ______________________________

5. Estimated Dimensions:

Length ____________________feet (conversions: 1 meter = 3.28 ft; 1 yard = 3 ft)

Width _____________________feet

Depth _____________________feet

Volume ____________________feet^3 (conversions: 1 meter^3 = 35.3 ft^3; 1 yard^3 = 27 ft^3)

Estimations from (e.g., field evaluation, aerial photos): ___________________________

____

6. Predominate Type of Material:

a. Rock __

b. Debris (coarse soils) __

c. Earth (fine soils) __

d. Fill __

7. Predominate Type of Movement:

a. Fall/Topple __

b. Flow __

c. Slide: Translational __

Rotational __

d. Spread __

8. Other Slide Characteristics:

a. Approximate original slope (e.g., 30 ± 5 degrees): ____________________________

Estimated from (e.g., 1:24K USGS topo map): ______________________________

b. Slide occurred in (please check all that apply):

__ Forested area __ Rural area

__ Harvested area __ Urban area

c. Contributing Factors (please check all that apply):

__ Road related

__ Other construction:

__ Preexisting slide

d. Damage caused by slide: _______________________________________

9. Additional Comments (please continue on back):

APPENDIX B. SOURCE CONTACT INFORMATION

Source_Nm	Unique_Ids	Organization	Phone number	Contact_Name	Title	Phone number	e-mail
BIA	1 to 4	Bureau of Indian Affairs (BIA) Roads	541-553-1634	—	—	—	—
BLMBurns	5	Bureau of Land Management-Burns District	541-573-4400	Terri Geisler	District Geologist	541-573-4400	—
BLMEugene	6 to 19	Bureau of Land Management-Eugene District	541-683-6600	Mary D'Aversa	—	541-683-2957	—
BLMSalem	20 to 391	Bureau of Land Management-Salem District	503-375-5646	Chester Novak	—	503-375-5626	—
CtyBenton	392 to 408	Benton County Public Works	—	Doug Sackinger	—	541-766-6601	—
CtyClack	409 to 420	Clackamas County Department of Transportation & Development	503-655-8521	Darrel Burnum	Road Maintenance Supervisor	503-650-3210	darrelb@co.clackamas.or.us
CtyClatsop	421 to 443	Clatsop County Public Works	503-325-8631	Barbara Cooper	—	503-325-8631	—
CtyCurry	444 to 450	Curry County Road Department	541-247-7097	Dan Crumley	Roadmaster	—	currycord@harborside.com
CtyDoug	451 to 474	Douglas County Public Works	—	Rob Paul	—	541-440-4481	—
CtyGrant	475	Grant County Road Department	—	Jim Walker	Road Supervisor	541-575-0138	—
CtyHoodR	476 to 480	Hood River County Public Works	—	Don Wiley	County Engineer	541-386-2616	—
CtyJack	481 to 484	Jackson County Roads and Parks Services	541-774-6236	Tim Hurn	Project Engineer	541-774-6236	hurta@Jacksoncounty.org
CtyJoseph	485 to 508	Josephine County Public Works	541-474-5460	Dave Buhl	Civil Engineer	541-474-5460	dbuhl@co.josephine.or.us
CtyLane	509 to 586	Lane County Public Works	541-682-6900	Chris Henry	—	—	—
CtyLinc	587 to 802	Lincoln County Road Department	541-265-5747	Mitzi Brown	—	541-574-1219	—
CtyLinn	803 to 817	Linn County Public Works	—	Steve Lucker	—	541-924-6903	—
CtyMarion	818 to 831	Marion County Public Works	503-588-5036	Garth Shull	Civil Engineer	503-588-5036	gshull@open.org
CtyMult	832 to 859	Multnomah County Transportation	—	Mike Phillips	Engineering Design Administrator	503-248-5050 ext. 29628	—
CtyWasco	860 to 863	Wasco County Public Works	—	Marty Matherly	Project Manager	541-296-2214	martym@gorge.net
DOGAMIdj	864 to 882	Oregon Department of Geology and Mineral Industries	503-731-4100	David James	Geologist	503-252-3940	dhjames@teleport.com
DOGAMIes	883 to 895	Oregon Department of Geology and Mineral Industries	503-731-4100	—	—	—	—
DOGAMItw	896 to 934	Oregon Department of Geology and Mineral Industries-Grants Pass Office	541-476-2496	Tom Wiley	Regional Geologist	541-476-2496	—
FEMA_OEM	935 to 1285	Federal Emergency Management Agency Region 10 & Oregon Emergency Management	503-378-2911	Denise Choin	—	503-378-2911 ext. 222	—
FHWA	1286 to 1455	Federal Highway Administration	503-399-5749	John Gernhauser	—	503-399-5749	—
Fremont	1456	USDA-Fremont National Forest	541-947-2151	John Crumrine	Operations Engineer	541-947-6309	—
GRI	1457	Geotechnical Resources, Inc. (GRI)	503-641-3478	George Freitag	Project Geologist	503-641-3478	gfreitag@gri.com
Gweb_rd	1458 to 1724	Governor's Watershed Enhancement Board	541-757-4263	Susanne Maleki	—	{541-757-4263	malekis@ccmail.orst.edu
Gweb_str	1725 to 1728	Governor's Watershed Enhancement Board	541-757-4263	Susanne Maleki	—	ext. 233}	malekis@ccmail.orst.edu
Hinkle	1729 to 1887	—	—	Jason Hinkle	PSU M.S. student-now at ODF	503-945-7468	Jason.Hinkle@state.or.us

Metro_PSU	1888 to 2592	Portland Metro Data Resource Center / Portland State University	503-797-1742 / 503-725-3389	Steve Erickson / Scott Burns	— / —	503-797-1595 / 503-725-3389	— / burnss@pdx.edu
MtHFCkl	2593 to 2755	USDA-Mount Hood National Forest	503-622-4822	Liz O'Dea	—	503-668-1482	—
MtHFCkpt	2756 to 2991	USDA-Mount Hood National Forest	503-622-4822	Liz O'Dea	—	503-668-1482	—
Ochoco_1	2992 to 2994	USDA-Ochoco National Forest	541-416-6500	Caroline Gordon	—	541-416-6518	—
Ochoco_2	2995 to 3009	USDA-Ochoco National Forest	541-416-6500	Caroline Gordon	—	541-416-6518	—
ODF_Astoria	3010 to 3031	Oregon Department of Forestry-Astoria District	503-325-5451	Rick Thoreson	Engineering Coordinator	503-325-5451	—
ODF_FebDF	3032 to 3269	Oregon Department of Forestry (February study sites, "debris_path.shp")	—	Jim Paul	—	503-945-7487	Jim.P.Paul@state.or.us
ODF_FebLS	3270 to 3554	Oregon Department of Forestry (February study sites, "landslides.shp")	—	Jim Paul	—	503-945-7487	Jim.P.Paul@state.or.us
ODF_Kilchis	3555 to 3714	Oregon Department of Forestry (Kilchis study site, "slides.shp")	—	Jim Paul	—	503-945-7487	Jim.P.Paul@state.or.us
ODF_NovDF	3715 to 3905	Oregon Department of Forestry (November study sites, "debris_path.shp")	—	Jim Paul	—	503-945-7487	Jim.P.Paul@state.or.us
ODF_NovLS	3906 to 4159	Oregon Department of Forestry (November study sites, "landslides.shp")	—	Jim Paul	—	503-945-7487	Jim.P.Paul@state.or.us
ODOT_MW	4160 to 4162	Oregon Department of Transportation	—	Mike Wilbur	AMC	541-686-7622	Michael.J.WILBUR@odot.state.or.us
ODOT_PC	4163 to 4164	Oregon Dept. of Transportation	—	Pat Creedican	District 10 Manager	541-388-6192	—
ODOT_r1	4165 to 4482	Oregon Department of Transportation-Region 1	503-731-8200	Amy Pfieffer	—	503-731-8302	—
ODOT_r2	4483 to 4507	Oregon Department of Transportation-Region 2	—	Bernie Kleutsch	—	503-986-2645	—
ODOT_r3	4508 to 4774	Oregon Department of Transportation-Region 3	—	Sue D'Agnese	—	541-957-3595	—
ODOT_r4	4775 to 4776	Oregon Department of Transportation-Region 4 Geology Unit	—	Russ Frost	Geology Team Leader	—	—
Rinne	4777	—	—	Rich Rinne	Senior Geologist	—	rrinne@aol.com
RogERFO	4778 to 4945	USDA-Rogue River National Forest	541-858-2200	Ron Brady	ERFO Coordinator	541-858-2357	—
RogFldPt	4946 to 5006	USDA-Rogue River National Forest	541-858-2200	Amanda McKinnis	—	541-858-2319	—
RogUpslp	5007 to 5058	USDA-Rogue River National Forest	541-858-2200	Amanda McKinnis	—	541-858-2319	—
SiskLS	5059 to 5475	USDA-Siskiyou National Forest	541-471-6500	Kevin Johnson	—	541-471-6527	—
Sius96	5476 to 7162	USDA-Siuslaw National Forest	541-750-7000	Courtney Cloyd	—	541-750-7154	—
UmatMW	7163 to 7228	USDA-Umatilla National Forest	541-278-3716	Caty Clifton	—	541-278-3822	—
UmpERFO96	7229 to 7275	USDA-Umpqua National Forest	541-672-6601	Ed Hall	—	541-957-3437	—
UmpERFO97	7276 to 7387	USDA-Umpqua National Forest	541-672-6601	Ed Hall	—	541-957-3437	—
WallWhit	7388 to 7391	USDA-Wallowa Whitman National Forest	—	Dennis Knapp	Special Projects Engineer	541-426-5654	—
WillDF	7392 to 8781	USDA Willamette National Forest	541-465-6521	Jennifer Lloyd	—	—	—
WillERFO	8782 to 9582	USDA Willamette National Forest	541-465-6521	Mark Truebe	—	541-465-6515	—

APPENDIX C: DATA DICTIONARY

Fields

Unique_ID
Source_Nm
Source_ID
TYPE
LONG
LAT
COUNTY
USGS_QUAD
PLSS
PLSSnoDLC
SUBBASIN
WATERSHED
Organization
Phone_Number1
Contact_Name
Title
Phone_Number2
Email
Slide_ID
Slide_Name
Hwy_Road_Name
Hwy_Road_Number
Milepost
Source_of_Location
Date
Length_feet
Width_feet
Depth_feet
Volume_cubic_feet
Dimensions_From
Type_of_Material
Type_of_Movement
Slope_degrees
Slope_Est_From
Slide_Occurred_In
Contributing_Factors
Damage
Comments
Additional_Info

Field Descriptions

Item: Unique_ID
Description: Unique identifier for each entry.
Field Type: Integer
Range: 1 to 9,582

Item: Source_Nm
Description: Codes for various data sources typically selected in relation to the name of the organization (see Organization field) or the contact individual (see Contact_Name field).
Field Type: Character
Field Width: 15
Coding: See listing in Appendix B.

Item: Source_ID
Description: Identifier associated with original source data. (Additional field that can be used for linking data sets.)
Field Type: Integer

Item: TYPE
Description: The type of GIS object used to represent the entry (either polygon, line, or point).
Field Type: Character
Field Width: 10
Coding:

Code	*Count*	*Description*
POLY	2,421	Polygon
POLYLINE	1,756	Polyline
POINT	5,405	Point

Item: LONG
Description: Longitude of the centroid of the object in decimal degrees.
Field Type: Decimal [11,6]
Range: -116.867 to –124.479

Item: LAT
Description: Latitude of the centroid of the object in decimal degrees.
Field Type: Decimal [11,6]
Range: 41.947 to 46.312

Item: COUNTY
Description: County name within which the centroid of the entry is located. Based on a GIS overlay with an approximately 1:100,000-scale Oregon County polygon layer. The source file for the overlay is "County.e00" obtained from the Oregon Geospatial Data Clearinghouse (http://www.sscgis.state.or.us/data/themes.html). For the 53 entries across the border into California, the COUNTY designation is "CA," and for the 30 entries in Washington, the COUNTY designation is "WA."
Field Type: Character
Field Width: 30

Item: USGS_QUAD
Description: U.S. Geological Survey 7.5-minute quadrangle name within which the centroid of the entry is located. Based on a GIS overlay with the "Quadindx.shp" statewide quadrangle coverage available from the Oregon Geospatial Data Clearinghouse (http://www.sscgis.state.or.us/data/themes.html). For the 53 entries across the border into California, the USGS_QUAD designation is "CA," and for the 30 entries in Washington, the USGS_QUAD designation is "WA."
Field Type: Character
Field Width: 30

Item: PLSS
Description: Township, range, and section designations within which the centroid of the entry is located. Based on a GIS overlay with the approximately 1:100,000-scale statewide polygon coverage "Pls.shp" obtained from the Oregon Geospatial Data Clearinghouse (http://www.sscgis.state.or.us/data/themes.html). For the 53 entries across the border into California, the PLSS designation is "CA," and for the 30 entries in Washington, the PLSS designation is "WA."
Field Type: Character
Field Width: 15

Item: PLSSnoDLC
Description: Township, range, and section designations *without* Donation Land Claims (DLCs) within which the centroid of the entry is located. Based on a GIS overlay with the approximately 1:100,000-scale statewide polygon coverage "Plsnodlc.shp" obtained from the Oregon Geospatial Data Clearinghouse

(http://www.sscgis.state.or.us/data/themes.html). For the 53 entries across the border into California, the PLSSnoDLC designation is "CA," and for the 30 entries in Washington, the PLSSnoDLC designation is "WA."
Field Type: Character
Field Width: 15

Item: SUBBASIN
Description: Name of watershed subbasin within which the centroid of the entry is located. Based on GIS overlays with the approximately 1:24,000-scale polygon coverages "westwbnd.shp" for the western portion of the state and "orwater.shp" for the east. The "orwater.shp" coverage was used only in areas outside the "westwbnd.shp" coverage. Both data sets were obtained from the Oregon Geospatial Data Clearinghouse (http://www.sscgis.state.or.us/data/themes.html). For the 30 entries in Washington, the SUBBASIN designation is "WA."
Field Type: Character
Field Width: 30

Item: WATERSHED
Description: Designation of fifth-field watershed within which the centroid of the entry is located. Based on GIS overlays with the approximately 1:24,000-scale polygon coverages "westwbnd.shp" for the western portion of the state and "orwater.shp" for the east. The "orwater.shp" coverage was used only in areas outside the "westwbnd.shp" coverage. Both data sets were obtained from the Oregon Geospatial Data Clearinghouse (http://www.sscgis.state.or.us/data/themes.html). For the 30 entries in Washington, the WATERSHED designation is "WA." The 84 entries in eastern Oregon do not have an assigned WATERSHED; these entries are designated as "N/A" for "Not Applicable."
Field Type: Character
Field Width: 55

Item: Organization
Description: The organization (company/agency) from which the entry information was obtained.
Field Type: Character
Field Width: 90
Coding: See listing in Appendix B.

Item: Phone_Number1
Description: Phone number for the contributing organization (as of the last correspondence).
Field Type: Character
Field Width: 25
Coding: See listing in Appendix B.

Item: Contact_Name
Description: Contact individual for the entry.
Field Type: Character
Field Width: 15
Coding: See listing in Appendix B.

Item: Title
Description: Title information for the contact individual.
Field Type: Character
Field Width: 36
Coding: See listing in Appendix B.

Item: Phone_Number2
Description: Phone number for the contact individual (as of the last correspondence).
Field Type: Character
Field Width: 23
Coding: See listing in Appendix B.

Item: Email
Description: E-mail address for the contact individual.
Field Type: Character
Field Width: 33
Coding: See listing in Appendix B.

Item: Slide_ID
Description: Additional identifiers provided by sources. Included as another option for linking with original data sets, though it is neither a comprehensive nor a consistently unique identifier.
Field Type: Character
Field Width: 15
Count: 7,326

Item: Slide_Name
Description: Mixture of identifiers provided by sources. Included as another option for linking with original data sets, though it is also neither a comprehensive nor a consistently unique identifier.
Field Type: Character
Field Width: 95
Count: 4,809

Item: Hwy_Road_Name
Description: Highway or road name.
Field Type: Character
Field Width: 37
Count: 889

Item: Hwy_Road_Number
Description: Highway or road number.
Field Type: Character
Field Width: 15
Count: 2,792

Item: Milepost
Description: Milepost number or range.
Field Type: Character
Field Width: 13
Count: 1,905

Item: Source_of_Location
Description: Indication of how the location data were incorporated into the consolidated database and original methods of mapping (e.g., from aerial photographs, field investigations, etc.).
Field Type: Character
Field Width: 77
Count: 9,582

Item: Date
Description: Date(s) of slide activity.
Field Type: Character
Field Width: 27
Coding:

Code	*Count*	*Description*
Feb 9, 1996	130	Landslide movement initiated February 9, 1996.
Feb-96	5,025	Associated with the February 1996 event.
Nov-96	1,150	Associated with the November 1996 event.
Nov/Dec-96	614	Associated with the storms of November and December 1996.
1996	300	Moved in 1996 — most likely associated with one or both storms.

Code	*Count*	*Description*
Dec ‘96-Jan ‘97	326	Associated with the December 1996 and January 1997 events.
1997	123	Moved in 1997 — most likely associated with storms.
“Other”	105	Other dates provided (multiple episodes, earlier or later years, etc.)
“Blank”	1,809	No date specified.

Item: Length_feet
Description: Estimated length of the slide in units of feet.
Field Type: Character
Field Width: 10
Count: 3,552
Range: 5 to 6,500

Item: Width_feet
Description: Estimated width of the slide in units of feet.
Field Type: Character
Field Width: 10
Count: 3,339
Range: 1 to 1,200

Item: Depth_feet
Description: Estimated depth of the slide in units of feet.
Field Type: Character
Field Width: 10
Count: 1,489
Range: 0.1 to 100

Item: Volume_cubic_feet
Description: Estimated volume of slide material in cubic feet.
Field Type: Character
Field Width: 15
Count: 2,170
Range: 5.4 to 12,000,000

Item: Dimensions_From
Description: Description of how dimension measurements were made or estimated.
Field Type: Character
Field Width: 81
Count: 3,449

Item: Type_of_Material
Description: Predominate type of landslide material (rock, earth, debris, fill, other), following the nomenclature of Cruden and Varnes (1996).
Field Type: Character
Field Width: 19
Coding:

Code	*Count*	*Description*
Rock	62	Slide mass predominately characterized by rock material.
Debris	2,129	Slide mass predominately characterized by debris material.
Earth	598	Slide mass predominately characterized by earth (fine soil) material.
Fill	8	Slide mass predominately characterized by fill material.
“Other”	37	Multiple or other material type designations.
“Blank”	6,748	No type specified.

Item: Type_of_Movement
Description: Predominate type of movement exhibited by the slide mass (fall / topple, flow, translational slide, rotational slide, spread, other), following the nomenclature of Cruden and Varnes (1996).

Field Type: Character
Field Width: 24
Coding:

Code	*Count*	*Description*
Fall	57	Failure mechanism predominately characterized as a fall.
Fall/Topple	14	Failure mechanism predominately characterized as a fall/topple.
Flow	2,301	Failure mechanism predominately characterized as a flow.
Slide	87	Failure mechanism predominately characterized as a slide.
Slide-Translational	577	Failure mechanism predominately characterized as a translational slide
Slide-Rotational	137	Failure mechanism predominately characterized as a rotational slide.
Slide-Translational/Flow	29	Failure mechanism characterized by translational slide into a flow.
Slide-Rotational/Flow	146	Failure mechanism characterized by rotational slide into a flow.
"Other"	6	Multiple or other failure mechanism designations.
"Blank"	6,228	No type specified.

Item: Slope_degrees
Description: Estimated slope angle recorded in units of degrees.
Field Type: Character
Field Width: 22
Count: 1,571
Range: 5 to 90

Item: Slope_Est_From
Description: Description of how slope measurements were made or estimated.
Field Type: Character
Field Width: 38
Count: 1,520

Item: Slide_Occurred_In
Description: Characteristics of the slide location.
Field Type: Character
Field Width: 29
Coding:

Code	*Count*	*Description*
Forested Area	467	Slide occurred in forested area.
Harvested Area	683	Slide occurred in recently harvested area.
Rural Area	35	Slide occurred in a rural setting.
Urban Area	2	Slide occurred in an urban setting.
Forested Area, Rural Area	40	Slide occurred in a rural, forested area.
Forested Area, Urban Area	7	Slide occurred in an urban, forested area.
Harvested Area, Rural Area	3	Slide occurred in a rural, harvested area.
Harvested Area, Urban Area	1	Slide occurred in an urban, harvested area.
"Blank"	8,344	No entry specified.

Item: Contributing_Factors
Description: Noted factors contributing to the failure.
Field Type: Character
Field Width: 94
Coding:

Code	*Count*	*Description*
Road Related	1,193	Failure was road related.
Road Related — Cutslope	417	Failure was associated with a road cutslope.
Pre-existing slide	33	Failure was associated with a preexisting slide area.
Likely pre-existing slide	8	Failure within what appears to be a preexisting slide area.
"Other"	92	Multiple or other factors designated.
"Blank"	7,839	No entry specified.

Item: Damage
Description: Account of damage associated with the slope failure.
Field Type: Character
Field Width: 237
Count: 638

Item: Comments
Description: Additional comments on the database entry.
Field Type: Character
Field Width: 254
Count: 4,752

Item: Additional_Info
Description: Listing of known reports and / or additional information for the entry.
Field Type: Character
Field Width: 180
Coding:

Code	*Count*	*Description*
"YES-…"	7,485	Additional information is available and sources are provided if known.
"Blank"	2,097	Additional data is not known to be available at this time.