Landslide inventory and main geomorphological features affecting slope stability in the Picentino river basin (Campania, southern Italy)

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1. Introduction

Geomorphological mapping allows to depict the effects of the main denudational processes acting in a given area, in terms of forms and deposits (Hansen, 1984; Wieczorek, 1984). By properly distinguishing landforms related to ancient, inactive processes with respect to recent, active ones, cues on trends of landscape evolution can be obtained (Bruschi, Coratza, Piacentini, & Soldati, 2012). Geomorphological maps are complex graphic reports that require specific scientific skills (Brunsden, Doornkamp, & Jones, 1978), and can support urban planning and risk management. Depending on environmental conditions, slope materials, and on age, type and extent of the surveyed phenomena, the geomorphological mapping of slope movements may result in a quite difficult task (Keaton & DeGraff, 1996).

In zones characterized by high landslide hazard, inventory maps are commonly employed to evaluate landslide distribution, typology, and magnitude, and can be used in further analyses of controlling factors (cf., e.g. Iovine & Merenda, 1993; Malamud, Turcotte, Guzzetti, & Reichenbach, 2004; Morgan, Iovine, Chirico, & Wieczorek, 1999; Parker et al., 2011). Moreover, such maps provide a crucial contribution toward landslide susceptibility, hazard and risk evaluation (cf., e.g. Guzzetti, Carrara, Cardinali, & Reichenbach, 1999; Guzzetti, Reichenbach, Ardizzone, Cardinali, & Galli, 2006; Iovine, Greco, Gariano, Pellegrino, & Terranova, 2014; Terranova et al., 2016; van Westen, van Asch, & Soeters, 2006; Varnes & IAEg, 1984; Wieczorek, Morrissey, Iovine, & Godt, 1998).

Inventory maps can be distinguished into ‘archive’ or ‘geomorphological’ inventories (Guzzetti et al., 2012). In the first case, information on landslides is derived from the literature. The second can be historical, when they include the effects of a number of events, occurred over periods of tens to thousands of years (e.g. Conforti, Muto, Rago, & Critelli, 2014; Iovine, Parise, & Crescenzi, 1996; Wieczorek et al., 1998). Geomorphological inventory maps can also be event-based, i.e. related to specific triggering events (e.g. Ardizzone et al., 2012; Iovine & Merenda, 1996; Iovine & Petrucci, 1998; Morgan et al., 1999; Rago et al., 2017) or to multi-temporal events (e.g. Bianchini et al., 2014).

Methods adopted to prepare landslide inventory maps depend on purpose and expected use, extent of the study area, scale and quality of data, available resources, and experience of investigators (Guzzetti et al., 2012; van Westen, Castellanos Abella, & Sekhar, 2008). Nevertheless, each technique is characterized by a certain degree of subjectivity (e.g. Ardizzone, Cardinali, Galli, Guzzetti, & Reichenbach, 2007; Brardinoni, Slaymaker, & Hassan, 2003; Carrara, Cardinali, & Guzzetti, 1992; Galli, Ardizzone, Cardinali, Guzzetti, & Reichenbach, 2008; Guzzetti, Cardinali, Reichenbach, & Carrara, 2000; van Westen et al., 2006), thus efforts...
to refine tools to objectively evaluate quality of inventory maps should further be encouraged.

In this study, a 1:25,000 landslide inventory map of geomorphological/historical type is presented (Main Map), focused on the main geomorphological features affecting slope stability in the Picentino river basin (Campania, southern Italy). The map includes original geological-geomorphological data that may be relevant for further analyses of landslide susceptibility, hazard and risk in the study area.

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In the map, among slope movements, shallow landslides (with thickness up to 10 m, cf. Hutchinson, 1995) are distinguished from deeper ones. The first commonly develop as high-intensity phenomena, and may affect transportation infrastructures and urbanized areas with severe consequences.

Based on morphological freshness, all landslides are classified into recent and old. Further items, mainly related to tectonics, karstic and erosion processes on slopes and along the valleys, and anthropized sectors are included. In a set of additional 1:100,000 thematic maps, the main factors controlling shallow-landslide susceptibility (i.e. lithotype, thickness of regolith, slope, and land use) are shown. The distribution of slope movements with respect to the main controlling factors is briefly discussed. Finally, further inventories of shallow landslides, derived from geo-hydrological plans provided by the Campanian Basin Authorities, are compared to data presented in this study. The relevance of suitable inventories – especially for shallow landslides – within procedures of susceptibility assessment is finally underlined.

2. The study area

The Picentino river, whose basin extends about 145 km², originates at 1650 m a.s.l. on Mount Accéllica, and flows south-westward to the Tyrrhenian Sea (cf. Figure 1 and Main Map). The river originates in the Picentini Mountains, a relevant morpho-structural unit of the Campanian-Lucanian Apennine Chain, bordered by sub-vertical, WNW–ESE and, subordinately, NNE–SSW trending normal faults (Ortolani, 1975). In the study area, the Varicoloured Clays Unit (Cretaceous–Early Miocene) is tectonically superimposed on limestone-dolomite rocks of the Campanian-Lucanian Platform (Triassic–Jurassic) (D’Argenio, Pescatore, & Scandone, 1973). The above rocks are strongly tectonized, mainly due to Langhian overthrusting on the Lagonegro Unit (Scandone, 1967), and covered by Late Quaternary pyroclastic deposits (Brancaccio, Cinque, Russo, & Sgambati, 1998), commonly reworked into volcanoclastic deposits. Late Pleistocene–Holocene gravel and sand with peaty clay intercalations crop out along the coast. Fluvial and fluvial-deltaic deposits, terraced in multiple orders, are observable along the main valley.

From a morphological point of view, the basin can be split into three sectors: an inner mountainous sector, an intermediate hilly sector, and a coastal flat sector. Remnants of an erosion paleo-surface, modelled between Late Miocene and Early Pleistocene (Brancaccio et al., 1987; Capaldi, Cinque, & Romano, 1988), can be found on tops of monoclinal blocks, due to dismembering of an original massif by Quaternary extensional tectonics phases. Such remnants are commonly

Figure 1. Shaded relief of central Campania, with delimitation (in red) of the Picentino river basin. Main toponyms mentioned in the text are also shown.
masked by a regolith cover, suggesting a phase of morphological maturity of the landscape. On the western margin of the basin, the southern hillslope of Mt. Tobenna is characterized by a summit vertical cliff and a 40° planar slope cut in carbonate rocks. The slope is marked at the base by an NE–SW normal fault, and can be interpreted as a recession slope, according to the Lehmann denudation model (cf. Brancaccio, Cinque, & Sgrosso, 1978).

Slope movements pose a frequent threat to people and urbanized sectors in Campania (Monti, D’Elia, & Tocaceli, 2007). In the study area, shallow landslides (mostly, debris flows – cf. below) characterized by high intensities and deeper slope movements of various types can be found (cf., e.g. Papini, Budetta, Di Crescenzo, & Nappi, 2008).

Some lineaments of the hydrographic network clearly develop along structural elements. The terminal reach of the Picentino river develops in a wide alluvial plain (width: ca. 800 m) with an average slope of 0.7%. Upstream, between Campigliano and the junction with the Rio Secco stream near Giffoni Valle Piana (146 m a.s.l.), the slope of the main channel increases to 1.3%. In its northernmost portion, the river results quite incised, and its slope increases to 97.1%. As shown in Figure 2, the innermost reaches of the Prepezzano and Rio Secco streams are characterized by slopes lower than those of the Picentino river. In the mountainous sector, the Picentino river and the Prepezzano stream have a dendritic network. South of the alignment between Montecorvino Rovella and Prepezzano (marked by faults belonging to the Apennine system), they both flow down meandering to the coast, with an average NE–SW trend. Northward of the same alignment, the Prepezzano and Rio Secco streams show a NNW–SSE trend. Differently from the Picentino and the Prepezzano cases, the Rio Secco valley remains quite wide (up to ca. 600 m) even north of the Montecorvino Rovella–Prepezzano structural alignment.

In climatic terms (Köppen & Geiger, 1954), a gradual shift is recognized from the Csb type of climate that characterizes the lowlands closer to the sea, to the Csf up to Csa types in a limited area near Mt. Cervialto. The average annual temperatures in the basin vary between 12°C in the internal mountainous area and 16°C by the coast (Ducci & Tranfaglia, 2008). The area is exposed to moist Atlantic winds: as a result, yearly rainfalls up to 1000 mm are recorded by the coast, reaching 2000 mm at M. Cervialto (1809 m a.s.l.) by the Apennine divide (Servizio Idrografico, 1948–1999). Rainy days are 95 per year, on average. In October–December, about 30% of annual rainfall is recorded in 34 rainy days. Another 30% falls in 30 rainy days from April to September. Afternoon thunderstorms frequently hit the inland mountainous sectors between September and October.

In proximity to the study area, rainy events of high intensity are quite frequent (Vennari, Parise, Santangelo, & Santo, 2016). In historic time, remarkable ground effects were induced by heavy rainfalls in the study area and its surroundings in 1581 (Esposito et al., 2011), mainly in terms of flooding and shallow landslides. In the last century, the most relevant events occurred nearby in the Amalfi Coast in 1954 (cf. Esposito, Porfido, & Violante, 2004), and at Pizzo d’Alvano in 1998 (Del Prete, Guadagno, & Hawkins, 1998; Iovine, Di Gregorio, & Lupiano, 2003), inducing severe geo-hydrological effects, numerous victims and serious damage.

3. Method

The landslide inventory map with main geomorphological features affecting slope stability in the Picentino river basin (Main Map, at 1:25,000) was obtained by interpreting four sets of air-photographs: IGM 1954, panchromatic, at scale 1:33,000; SCAME 1974 and IGM 1980, both panchromatic, at scale 1: 18,000; Rossi s.r.l. 1998, colour, at 1:20,000. Field investigations were also performed at sample sites in 1998 and early 1999, i.e. shortly after the last major geo-hydrological event occurred in the study area and surroundings.

The inventory of landslides included in the Main Map belongs to the cited geomorphological/historical type (in the following, ‘historical 1998’). Slope movements with thickness up to 10 m (i.e. including ‘superficial’ and ‘shallow’ cases, cf. Hutchinson, 1995) are distinguished from deeper ones. The first (‘shallow landslides’, for the sake of brevity) are mostly debris slide-debris flows (soil slip-debris flows, sensu

![Figure 2. Longitudinal profiles (talweg) of the Picentino river and of its main tributaries (Prepezzano and Rio Secco streams).](image-url)
Campbell, 1975), therefore characterized by a complex style of activity (cf. Cruden & Varnes, 1996). In most cases, such slope movements are channelized: according to Hung, Evans, Bovis, and Hutchinson (2001), they can be classified as debris flows. Deeper landslides are mainly characterized by ‘intermediate’ thickness (up to 30 m – cf. Hutchinson, 1995); they mostly involve debris and are distinguished on the base of the type of movement.

Denudational forms and deposits are also classified based on morphological freshness (cf., e.g. Keaton & DeGraff, 1996). Recent slope movements generally show sharp features, with bare surfaces or a poor cover of young vegetation, whereas older ones are characterized by weak and subtle features and are broadly covered by mature vegetation. Accordingly, areas characterized by well-recognizable and interconnected landslide sources, flow paths and debris fans are mapped as recent debris-flow basins. Similarly, sectors showing a fresh signature of slope erosion processes (essentially, sheet / rill erosion) are reported. On the other hand, depleted zones with only subdued evidence of older slope movements and erosion, with fans not clearly ascribable to any fresh source, are classified as old debris-flow basins. Also due to the scale of investigation, evidences of slope instability could not always be ascribed to well-defined landslide bodies: in such cases, unstable zones – modelled by ancient phenomena and/or affected by soil creep – are mapped as ‘landslide areas’.

Sectors characterized by either bedrock outcrops or a thin regolith cover (up to 0.5 m) are mapped on the basis of literature (cf. Di Nocera, 1998; GEORES, 2011) and field surveys. Suspended valleys and remnants of erosion paleosurfaces, colluvial deposits at the base of slopes, valley bottoms with thick alluvial deposits (generally >20 m), and alluvial fans are also reported. Morphological scarps related to gravitational, tectonic or structural features and edges of river terraces are mapped. The main structural elements are distinguished into normal faults, strike-slip faults, thrust faults, and faults of unspecified type. Faults were derived from the Geological Map of Italy (at scale 1:50,000 – CARG, 2009) and mapped at scale 1:25,000 based on air-photo interpretation and field inspections, after checking in the ITHACA Catalogue (available at http://sgi1.isprambiente.it/geoportal/catalog/main/home.page). Finally, the main roads, the hydrographic network (derived from 1:25,000 topographic maps – cf. Istituto Geografico Militare, 1995), and main/secondary contour lines (equidistance of 100 and 50 m, respectively) are included.

The following additional thematic maps (at 1:100,000 scale), concerning the main control factors on slope stability, are included at the bottom of the Main Map:

- the geo-lithological map of the Picentino river basin (Map A), obtained from the Geological Map of Italy (at scale 1:100,000 – Servizio Geologico d’Italia, 1965, 1969, 1970), and the Geological Map of Italy (at scale 1:50,000 – CARG, 2009), integrated by interpretation of air-photographs and field surveying. Lithotypes are grouped into four classes, based on main geo-mechanical properties: alluvial deposits (Quaternary); conglomerate, travertine and pyroclastic deposits (Plio-Quaternary); carbonate (Mesozoic); flysch (Cenozoic). In the same map, the main tectonic features are also included.
- the map of regolith thickness (Map B), derived from Di Nocera (1998), GEORES (2011), and field surveys. Thickness values are grouped into five classes: bare bedrock, [0–0.5 m], [0.5–2 m], [2–5 m], >5 m. Alluvial deposits along the main valleys, and anthropized sectors (e.g. urbanized areas, landfills) are also reported.
- the slope map (Map C), derived from the TINITALY/01 Digital Terrain Model (Tarquini et al., 2007), with a square cell of 10 m × 10 m. Slope values are grouped into five classes: [0–10°], [10–20°], [20–30°], [30–40°], [40–90°].
- the land-use map (Map D), obtained from the ‘level 2’ of the Corine Land Cover (ISPRRA, 2012). Land-use classes are: Permanent crops (2.2); Heterogeneous agricultural areas (2.4); Arable land (2.1); Scrub and/or herbaceous vegetation associations (3.2); Forests (3.1); Urban fabric (1.1); Industrial, commercial and transport units (1.2).

Two sets of maps (named ‘PSAI’ maps – cf. geomorphological plans, prescribed by Law n. 267, 3 August 1998) were also obtained for the study area, based on landslide inventories realized by:

- the regional Basin Authority ‘Destra Sele’ in 2002 at 1:25,000 (cf. http://www.difesa.suolo.regione.campania.it/index.php – retrieved in June 2017). Such ‘PSAI 2002’ maps are based on air-photos taken in 1998 (Rossi s.r.l., colour, at 1:10,000; Nuova Avioriprese s.r.l., panoramic, at 1:13,000).
- the regional Basin Authority ‘Campania Sud’ in 2011 (updated in 2016) at 1:5,000 (cf. http://www.adbcampaniasud.it/web/pianificazione/psai/riperimetrazioni/dx-sele – retrieved in December 2017). Such ‘PSAI 2011’ maps are based on colour air-photos taken in 2004–2005 (ICE-GEIE, colour, scales 1:11,000–1:12,000).

In Maps E–H (on the right of the Main Map), the inventory maps (historical 1998, PSAI 2002, and PSAI 2011) are merely overlapped for comparison purposes, and precisely:
• in Map E, areas affected by shallow landslides in the historical 1998 and in the PSAI 2002 inventories are mapped. The 1998 inventory is shown in red (recent cases), and in yellow and grey (old cases, sources and fans, resp.); the PSAI 2002 inventory is in green; areas affected by landslides in both inventories are in black.
• in Map F, areas affected by shallow landslides in the historical 1998 and in the PSAI 2011 inventories are mapped. The 1998 inventory is shown as in Map E; the PSAI 2011 inventory is in blue; areas affected by landslides in both inventories are in black.
• in Map G, areas affected by shallow landslides in the PSAI 2002 and in the PSAI 2011 inventories are mapped. The PSAI 2002 inventory is shown in green; the PSAI 2011 inventory is in blue; areas affected by landslides in both inventories are in black.
• in Map H, the union of all the above inventories is mapped: areas affected by landslides in at least one of the inventories (1998 ∪ 2002 ∪ 2011) are in yellow; areas affected by landslides in the three inventories (1998 ∩ 2002 ∩ 2011) are in black. The shaded relief is derived from TINITALY/01 (Tarquini et al., 2007). In addition, histograms depict landslide indexes with respect to the main predisposing factors (lithotype, regolith thickness, slope, and land use) for areas affected by shallow landslides in either one or more inventories. Indexes are computed as

\[ L_i = L_a/C_a \]  

(1)

where \( L_i \) is the landslide index, \( L_a \) is the area affected by landslides in a given class of a factor, and \( C_a \) is the total area of the same class.

4. Results

The main control factors on slope stability are mapped in Maps A-D (cf. Main Map). Carbonate bedrock extends over about 60% of the basin in the mountainous sector, followed by flyschoid rocks (16%) in the hilly sector; alluvial deposits crop out along the main valley bottoms (13%), whereas conglomerate, travertine, and reworked pyroclastic terrains are to be found in the plain areas (12%). Regolith thickness ranges between 0.5 and 2 m over 55% of the study area, followed by the 2–5 m class (22%); values greater than 5 m can be found along the main valleys and at base of slopes (14%); bedrock crops out in only 1% of the basin, and shows a thin cover (up to 0.5 m) in ca. 4%. Slope values do not exceed 10° in about 28% of the basin; slope ranges between 10° and 40° in 63% of the study area, with steepest angles characterizing the remaining 9%. As for land use, most of the basin is classified as forests (52%), followed by heterogeneous agricultural areas (23%) and permanent crops (9%); the remaining sectors are mainly characterized by scrub and/or herbaceous vegetation associations (8%), followed by arable land (4%), urban fabric (3%), and industrial, commercial and transport units (1%).

In the historical 1998 landslide inventory (Main Map), shallow landslides affect ca. 6.3% of the basin, with recent phenomena amounting to 1.7%. Most of the mapped phenomena are characterized by multiple sources coalescing into debris-flow basins. If sources are considered, they affect 3.7% of the basin, with recent ones amounting to 0.2% (0.25 km²). Source indexes with respect to the considered control factors are shown in Figure 3. Over 91% of the source areas are on slopes with carbonate bedrock (\( L_i = 71.3\% \) for recent cases), followed by conglomerate, travertine and pyroclastic deposits (\( L_i = 8\% \), that increases to 28% for recent cases). Most source areas (\( L_i = 65\% \)) can be found on 0.5–2 m thickness of regolith, followed by the 2–5 m class (\( L_i = 31\% \)); for recent cases, 62% and 33% of the sources areas affect the same thickness classes. As regards slope, 78% of source areas can be found on the 20–40° classes, with similar values for recent cases. Finally, most source areas (\( L_i = 82\% \)) affect forests (\( L_i = 84\% \) for recent cases).

In the same inventory, slope movements of intermediate depth are mostly old, and affect 3.6% of the basin. Among them, complex earth slide-earth flows affect 3.5 km² of the basin area, followed by earth slides (1.7 km²), and earth flows (0.06 km²). At few locations, evidence of rock falls can also be found. Overall (Figure 4), they mainly affect flyschoid outcrops (\( L_i = 27.2\% \)), followed by conglomerate, travertine and pyroclastic deposits (\( L_i = 8.8\% \)), and by carbonate substrate (\( L_i = 1.8\% \)). As regards thickness of regolith, the greatest index pertains to the 2–5 m class (\( L_i = 9.4\% \)), followed by the 0.5–2 m class (\( L_i = 7.7\% \)) and bare bedrock (\( L_i = 2.5\% \)). Most cases develop on gentle slopes, with greatest values for the 10°–20° class (\( L_i = 14.8\% \)) and the 0°–10° class (\( L_i = 9.4\% \)). Arable land results to be the most affected by deeper slope movements (\( L_i = 31.4\% \)), followed by heterogeneous agricultural areas (\( L_i = 11.9\% \)) and permanent crops (\( L_i = 10.1\% \)). Landslide areas affect 4.2 km² (i.e. 2.9% of the basin). Overall, the area affected by gravitational processes in the historical 1998 landslide inventory amounts to 12.8% (18.5 km²).

The extent of areas involved in shallow landslides in the three considered inventories (historical 1998, PSAI 2002, and PSAI 2011) are summarized in Table 1. In the PSAI 2002 and PSAI 2011, shallow landslides affect 3.7% and 1.4% of the basin, respectively. If shallow slope movements from the three inventories are combined, the affected area increases to 9.7%. By including evidence of deeper slope movements and landslide areas, 16.1% of the basin (23.5 km²) is affected by slope instability. In Map H
landslide indexes ($L_o$) are shown with respect to the main predisposing factors. The highest values (13%) pertain to carbonate bedrock, with smaller values (5–6%) for all the remaining sediments; the highest indexes (15%) characterize the 2–5 m class of regolith thickness, followed by the 0.5–2 m (10%); slopes between 20° and 40° are the most affected (27%), with smallest values for gentler steep values (12%); permanent crops show the highest indexes (10%) among the land uses, followed by forests.
Table 1. Areas affected by shallow landslides in the considered inventories (historical 1998, PSAI 2002, PSAI 2011).

| Inventory map | Area (km²) | Area (%) |
|---------------|------------|----------|
| 1998          | 9.081      | 6.251    |
| 2002          | 5.393      | 3.712    |
| 2011          | 1.992      | 1.371    |
| 1998 ∩ 2002   | 1.302      | 0.896    |
| 1998 ∩ 2011   | 0.391      | 0.269    |
| 1998 ∩ 2002 ∩ 2011 | 0.221 | 0.152 |
| 1998 ∩ 2002   | 13.124     | 9.034    |
| 1998 ∩ 2011   | 10.686     | 7.355    |
| 2002 ∩ 2011   | 6.362      | 4.379    |
| 1998 ∩ 2002 ∩ 2011 | 14.015 | 9.647 |

Notes: Data related to recent and old phenomena are merged for each inventory. Values of quantitative comparisons (union and intersection) between the same inventories are also listed.

According to Figure 5, Maps E–H and Table 1, the best and worst agreements among shallow-landslide inventories resulted when comparing the historical 1998 with the PSAI 2002, and with the PSAI 2011, respectively: in fact, 1998 ∩ 2002 = 0.9%, and 1998 ∩ 2011 = 0.3%. On the other hand, the comparison between the PSAI 2002 and the PSAI 2011 inventories points out an intermediate level of agreement: 2002 ∩ 2011 = 0.7%. Finally, only ca. 0.2% of the basin area belongs to pixels classified as ‘shallow-landslide’ in all the three considered inventories (1998 ∩ 2002 ∩ 2011). In Figure 6, indexes are shown separately for each shallow-landslide inventory and for their intersections: values concerning lithotype are in Figure 6(a), regolith thickness in Figure 6(b), slope in Figure 6(c), and land use in Figure 6(d). The greatest figures again pertain to carbonate substratum in all the considered maps; the highest values concern the 2–5 m and 0.5–2 m classes of regolith thickness; for slope, greater indexes are to be found between 20° and 40°; the highest indexes characterize forests, followed by permanent crops in 1998 and by arable land in 2002.

5. Conclusion

In this study, a historical landslide inventory of the Picentino river basin is presented, with considerations on the main geomorphological features relevant to slope stability. Among slope movements, shallow landslides show the freshest evidence. They are more widespread in the middle-inner sector of the basin (NE of the southern Picentini fault), where they affect secondary roads and threaten villages. Notwithstanding their limited initial volumes, such type of phenomena may travel for long distances, entraining great amounts of material along their paths, and represent a great concern in terms of risk management due to their high-destructive potential.

Source sectors of shallow landslides are generally located on moderately-steep slopes mantled by colluvium. Numerous debris-flow fans are to be found at the outlet of secondary basins along the valleys. They commonly show steep sides and lobed fronts, and are associated to their sources through steep and narrow paths. On the other hand, alluvial fans are characterized by slighter convexities, and associated to larger supply basins with gentler gradients. In some cases, due to sediment intercalations originated by hyperconcentrated flows, debris-flow fans show less pronounced convexities, with disproportionate sizes with respect to the extent of the subtended basins. Due to topographical constrains, presence of adjacent fans, erosion processes and anthropic alterations, the shape of some fans significantly departs from typical truncated cones, resulting into elongated talus bodies. At places (e.g. nearby Prepezzano and Giffoni Valle Piana), detrital fans fed from opposite valley-flanks determine the partial obstruction of the water courses. Fresh forms and deposits testify to recent debris-flow phenomena, and are mapped from source areas to accumulation sectors. In other cases, gentler morphological evidence could be interpreted in terms of either older landslides (of the same type) or as effects of mass transport caused by severe slope erosion. Further sectors are affected by slope-instability phenomena of greater extent. These latter are, mainly, old complex earth slide-earth flows, followed by earth slides, and subordinately earth flows. Few rock falls can also be found downslope of cliffs in the mountainous sector of the basin.

The comparison of shallow landslides from the historical 1998, the PSAI 2002 and the PSAI 2011 inventories points out discrepancies that – except for slope movements triggered after 1998 – are reasonably ascribable to intrinsic limits that characterize photo-interpretative geomorphological mapping. In fact, inventories are strongly affected by type and quality of available data – like type, age (with respect to geohydrological events) and scale of air-photos; age of field surveys; scale of mapping; freshness of forms – as well as by surveying procedures. When considering shallow landslides in humid environments, further
difficulties generally arise due to their limited extent and rapid camouflage either for natural or artificial causes (this is even more true in cases of partial erosion of regolith at sources and along the paths). Furthermore, inventories of shallow landslides unavoidably focus on more recent, fresher forms and deposits with respect to timing of surveys and/or age of airphotos. Consequently, different inventories generally reflect – to some extent – the distribution of instability phenomena triggered by distinct rainfall events.

The above comparison allowed to remark the relevance of employing shallow-landslide inventories of adequate detail and accuracy in susceptibility analyses. Such maps may, in fact, fail to correctly depict the role of shallow landslides in a given area, by providing non-representative samples that may lead to misleading risk evaluations. Any attempt to model shallow-landslide susceptibility should therefore carefully take into account such type of limitations when selecting suitable inventories for calibration and validation purposes.

Software
Mapping was carried out by using the open sources software QGIS 2.18.16.

Geolocation information
Campania, southern Italy.

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