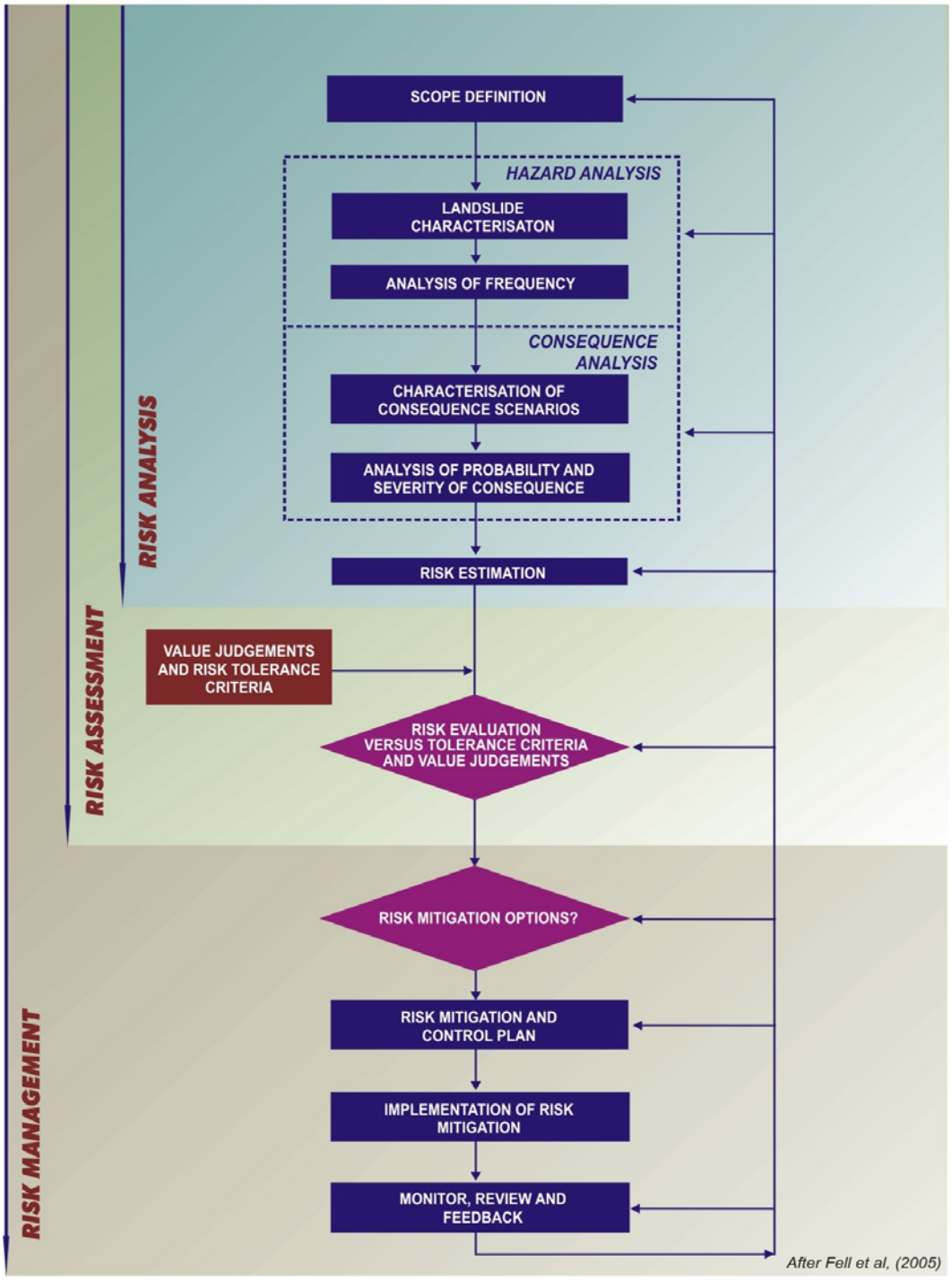
Figure 1. FRAMEWORK FOR LANDSLIDE RISK MANAGEMENT



4 DESCRIPTION OF LANDSLIDE SUSCEPTIBILITY, HAZARD AND RISK ZONING FOR LAND USE PLANNING

4.1 TYPES OF LANDSLIDE ZONING

Landslide Susceptibility Zoning involves the classification, volume (or area) and spatial distribution of existing and potential landslides in the study area. It may also include a description of the travel distance, velocity and intensity of the existing or potential landsliding. Landslide susceptibility zoning usually involves developing an inventory of landslides which have occurred in the past together with an assessment of the areas with a

potential to experience landsliding in the future, but with no assessment of the frequency (annual probability) of the occurrence of landslides. In some situations susceptibility zoning will need to be extended outside the study area being zoned for hazard and risk to cover areas from which landslides may travel on to or regress into the area being zoned. It will generally be necessary to prepare separate susceptibility zoning maps to show landslide sources and areas onto which landslides from the source landslides may travel or regress.

Landslide Hazard Zoning takes the outcomes of landslide susceptibility mapping, and assigns an estimated frequency (annual probability) to the potential landslides. It should consider all landsliding which can affect the study area including landslides which are above the study area but may travel onto it and landslides below the study area which may retrogressively fail up-slope into it. The hazard may be expressed as the frequency of a particular type of landslide of a certain volume or landslides of a particular type, volume and velocity (which may vary with distance from the landslide source) or, in some cases, as the frequency of landslides with a particular intensity where intensity may be measures in kinetic energy terms. Intensity measures are most useful for rock falls.

Landslide Risk Zoning takes the outcomes of hazard mapping and assesses the potential damage to persons (annual probability the person most at risk loses his or her life) and to property (annual value of property loss) for the elements at risk, accounting for temporal and spatial probability and vulnerability.

It will often be necessary to produce separate susceptibility, hazard and risk zoning maps for the different types of landslides affecting the area; e.g. for rock falls, small shallow landslides and deep-seated larger landslides. It may be necessary to produce separate maps for landslides from natural slopes and constructed slopes. If these are combined on to one map the boundaries may be confusing.

Appendix A in the Commentary has examples of landslide susceptibility, hazard and risk zoning for slopes which may experience rock falls, small landslides and large landslides.

5 GUIDANCE ON WHERE LANDSLIDE ZONING IS USEFUL FOR LAND USE PLANNING

5.1 GENERAL PRINCIPLES

Landslide zoning for land use planning is most commonly required at the local government level for planning urban development, but may be required by state or federal governments for regional land use planning or disaster management planning. It may also be required by land developers, those managing recreational areas or those developing major infrastructure such as highways and railways. The following are some examples of situations that are more susceptible to landslide occurrence. Their identification through landslide zoning would facilitate development planning and landslide risk management. It is the combination of having an area which is potentially subject to landsliding and the scale and type of development of the area that will determine whether landslide zoning is needed for land use planning. The type of zoning required is discussed in Section 6.

5.2 TOPOGRAPHICAL, GEOLOGICAL AND DEVELOPMENT SITUATIONS WHERE LANDSLIDING IS POTENTIALLY AN ISSUE

The following are examples where landsliding is potentially an issue in land use planning:

(a) Where there is a history of landsliding e.g:
- Deep-seated sliding on natural slopes.
- Widespread shallow slides on steep natural slopes.
- Rock falls from steep slopes and cliffs.
- Rock falls from coastal cliffs.
- Landslides in cuts, fills and retaining walls on roads, railways and associated with urban development.
- Large currently inactive landslides subject to undercutting by active erosion of the toe or subject to reactivation by development.
- Debris flows and earth slides from previously failed slopes.
- Widespread shallow creep type landslides in slopes of any inclination.

(b) Where there is no history of sliding but the topography dictates sliding may occur. e.g:
- Cliffs (coastal and inland).
- Natural slopes steeper than 35^o (landslide travel is likely to be rapid).
- Natural slopes between 20^o and 35^o (rapid landslide travel is possible).
- Steep, high road or rail cuttings.
- Steep slopes degraded by recent forest logging, forest fires and/or construction of roads.