Chapter 3
Land Use in the Drava Basin: Past and Present

Gerhard Karl Lieb and Wolfgang Sulzer

Abstract Current land use in the Drava River Basin (DRB) and its recent changes are detected from the data of the CORINE Land Cover (CLC) inventory, which allows a multitemporal analysis for the time period 1990–2012. Further data, like a DEM, were taken from the European Environmental Agency database. In order to provide a good overview, 11 land use classes were defined. Their distribution as well as their changes are shown in maps and analyzed statistically. The most striking results are (i) the clear dominance of the land use class forests (46% of the DRB), (ii) a pronounced differentiation of land use between the eastern and the western part of the catchment, both for natural and cultural reasons, and (iii) a relatively satisfactory environmental status, reflected among others by a high proportion of protected areas.

Keywords Land use change · Drava river basin · Protected areas
CORINE landcover

3.1 Introduction

The Drava River Basin (DRB) is a second-order sub-catchment of the Danube River Basin (Somogyi et al. 1983) and comprises more than 40.000 km^2, i.e. 5.0% of the Danube River Basin (Sommerwerk et al. 2009). Comparing the different second-order tributaries of the Danube with one another, the DRB is of special interest according, among others, to the following aspects (data taken from Sommerwerk et al. 2009).

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- The mean elevation of 760 m a.s.l. is exceeded only by another second-order catchment, that of the Inn River. This indicates the predominance of mountainous relief.
- Also with its mean annual precipitation of 1,121 mm, the DRB ranks second following the Inn catchment. This is due to the high precipitation in the alpine part of the catchment.
- The annual gross domestic product of 15,832 $ per inhabitant is the second highest, too, once again following the Inn catchment. However, the DRB's value is only the half of the Inn's value but twice the value of the entire Danube River Basin.

Naturally, these data hide the internal differentiation of the DRB which will be discussed in Sect. 3.3. However, economic welfare and especially mountainous relief show strong interdependencies with land use even on the entire catchment scale. Taking again the dataset of Sommerwerk et al. (2009) into account, the DRB shows outstanding data compared with other Danube tributaries in the following land use classes (which are named differently from those in the following text):

- Agricultural land covers only 28.7% of the basin, only the value of the Inn catchment is lower.
- Forests cover 45.8% of the DRB, which is the highest rate of all catchments (followed by the Sava catchment).
- Also the high values of natural grassland (9.0%; third highest) and sparse vegetation (3.9%, second highest) indicate once again mountainous relief.

In summary, the hydrological and land use characteristics seem to be largely influenced by the Alps. This is why this study first focuses on the topographical background and then on the historical developments which have strongly influenced land use patterns over time. Because land use and its change are considered important factors of river management, a closer look is taken into the most recent land use changes (Sect. 3.4), using the CORINE land cover dataset. Finally, land use is discussed with regard of nature protection and future perspectives.

3.2 Methods

As part of the CORINE program (Coordination of Information on the Environment), the European Union established a Europe-wide mapping of land cover and/or land use within the framework of the CORINE Land Cover project. A coordinated collection of information on the environment guarantees both a comparability of the data between the individual member states, as well as the possibility of addressing environmentally relevant questions and statements in the all-European context. Therefore, the result of this ongoing initiative provides comparable land use data from each of the DRB countries.

The main European Environmental Agency (EEA) data source is the Copernicus Land Monitoring Service which includes the CORINE Land Cover data set

(European Environmental Agency 2017a). The CORINE Land Cover (CLC) inventory was initiated in 1985; the data sets themselves were first elaborated in 1990. Updates have been produced in 2000, 2006, and 2012 and are based on the cooperation between EEA members, collaborating countries, and the Copernicus Programme (2017a). In 2018, a new inventory is planned. The concept and nomenclature of CLC is used as the quasi-standard for land cover and land use mapping in Europe. The data consists of an inventory of 44 classes. CLC uses a Minimum Mapping Unit (MMU) of 25 hectares (ha) for areal phenomena and a minimum width of 100 m for linear phenomena. The time series are complemented by change layers, which highlight changes in land cover with an MMU of 5 ha. The CORINE data sets of the DRB were provided by the Copernicus Land Monitoring Service (Copernicus Programme 2017b).

As already mentioned, the CLC nomenclature includes 44 land cover classes in a three-level hierarchy (European Environmental Agency 1999). The five "level 1" classes are "*artificial surfaces*", "*agricultural areas*", "*forests and semi-natural areas*", "*wetlands*" and "*water bodies*". In this study, specific CLC classes were merged to new land use classes in order to provide a special focus on catchment properties. This guarantees a better cartographic representation and clear (simplified) tables of specific CLC classes in the DRB. Finally 11 classes (Fig. 3.1) were used in the present CLC analysis:

1. *Built-up areas*: The original term is "artificial surfaces" which includes "urban pattern", "industrial, commercial and transport units", "mine dump and construction sites" and "artificial non-agricultural vegetated areas" of level 2.
2. *Arable land*: Instead of the level 1 class "Agricultural areas" the level 2 differentiation was used. All arable land in the DRB is "non-irrigated arable land".
3. *Permanent crops*: This class includes "vineyards", "fruit trees and berry plantations".
4. *Pastures*.
5. *Heterogeneous agricultural areas*: This class includes areas with "complex cultivation patterns" and "land principally occupied by agriculture, with significant areas of natural vegetation".
6. *Forests*: This class comprises "broad-leaved forest", "coniferous forest," and "mixed forest".
7. *Scrub and/or herbaceous vegetation associations*: Within this class "natural grassland", "moors and heathland," and "transitional woodland shrub" occur in the DRB.
8. *Open spaces with little or no vegetation*: This class consists of small parts of "beaches, dunes, sands" and largely of "bare rocks" and "sparsely vegetated areas".
9. *Glaciers and perpetual snow*: Widespread in the high mountain areas.
10. *Wetlands*: The level 1 CLC term was used and includes "inland marshes" and "peat bogs".
11. *Water bodies*: The class consists of "water courses" and "water bodies".

Fig. 3.1 Visual impressions of land use classes in the DRB (photos by Gerhad Karl Lieb)

The CLC data were analyzed together with a DEM (25 m) which was downloaded from the European Environmental Agency (2017b).

As far as the terms "land cover" and "land use" are concerned, the authors will use the latter one, being aware of the fact that land *cover* is the observed (bio)-physical substrate on the earth's surface. In contrast, land *use* is characterized by the arrangements, activities, and inputs people undertake in a certain land cover type to produce, change or maintain it. Definition of land use in this way establishes a direct link between land cover and the actions of people in their environment (FAO 2017).

3.3 Current Status and Background of Land Use

3.3.1 Physical-Geographical Background of Land Use

Land use patterns largely depend on natural conditions. Using the macro-scale European biogeographical division provided by the European Environmental Agency (2016) the DRB belongs to the "Alpine", the "Continental," and the "Pannonian Region". A similar subdivision was also used by Sommerwerk et al. (2009). Another approach, which allows a more detailed insight, was used by Mazúr et al. (1985) providing natural landscape types. According to their map, the entire DRB belongs to the temperate climate zone and has a share of two relief classes, lowlands and mountains. The latter class is further divided into the sub-classes "high mountains" (Alps) and "isolated mountain groups and mountains". The lowlands comprise a broad variety of different types of hilly regions (most widespread type: "accumulational-erosional hilly regions") and "floodplains" along the main rivers. Also within the mountainous region, there are a lot of subtypes ranging from "landscapes of the glacier and névé region" to "basins and wide intra-montane valleys" (which for tectonical reasons are of special significance for the southeastern Alps drained by the Drava River).

Going into more detail is, naturally, far beyond the scope of this chapter. Hence, further considerations are based on the rough distinction between the "alpine" and "pre-alpine region". To divide these two macroregions from each other, we used the Alpine perimeter information which is provided by the Alpine Convention (2017). This is reasonable because this political delineation is very close to the natural one (proved by Figs. 3.2 and 3.3) and is used most frequently in research on the Alps. Accordingly, the alpine area covers 55.3% of the DRB. On this basis, Table 3.1 shows the five land use classes which cover the largest portions of the two macroregions. The table clearly reflects the influence of physical conditions, especially by the limited occurrence of agricultural classes in the Alps. This is due to climatic and geomorphological restrictions (Fig. 3.2) which are also indicated by the large amount of open spaces with little or no vegetation. The latter are very widespread in the western part of the DRB with pronounced high-mountain character—glaciation is still widespread in the Hohe Tauern Range (glaciers and perpetual snow in 2012: 78 km^2) with Großglockner (3,798 m) as the highest summit in the catchment. It may be surprising that in both macro-regions forests are the dominant land use type. This cannot be explained by natural conditions, but mainly by the land ownership situation (Sect. 3.2).

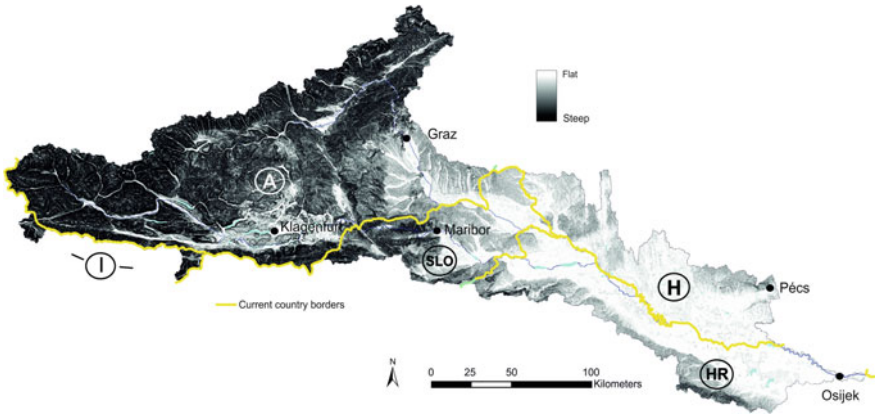

Fig. 3.2 Slope map of the DRB. *Data source* European Environmental Agency (2017b)

Table 3.1 The five most widespread land use classes in the alpine and pre-alpine regions of the DRB in 2012 (explanations in the text)

Alpine region			Pre-alpine region		
Land use class	km^2	%	Land use class	km^2	%
Forests	12,672.74	57.6	Forests	5,435.83	30.6
Scrub[a]	2,826.82	12.9	Arable land	4,871.89	27.4
Pastures	2,010.95	9.1	Heterog. agr.[a]	4,304.29	24.2
Open spaces[a]	1,536.26	7.0	Built-up area	916.23	5.2
Heterog. agr.[a]	1,314.37	6.0	Pastures	904.68	5.1
Others	1,629.10	7.4	Others	1,333.22	7.5
Total	21,989.24	100.0	Total	17,766.14	100.0

[a]*Scrub* scrub and/or herbaceous vegetation associations; *heterog. agr.* heterogeneous agricultural areas; *open spaces* open spaces with little or no vegetation

3.3.2 Historical Background of Land Use

As elsewhere in Central Europe, human presence dates back to prehistoric times in almost the entire DRB and the Romans were the first to establish infrastructure like roads and settlements to a larger extent. From the viewpoint of the present-day ethnicity, the immigration of Slavic tribes (earliest Middle Ages) from the East, the Hungarians (10th century) also from the East and the Bavarians (from the 8th century onwards) from the West was of great importance. Beginning with the turn of the first millennium, human settlement in the western and eastern parts of the DRB was different. Whereas the western part saw a quite continuous establishment of the Habsburg Empire with only a few interruptions of the development of cultural landscapes by wars, the lower eastern part can be labeled as a "region of borders and wars" (Schneider-Jacoby 1996). This is primarily due to the Ottoman

expansion, which reached the DRB around 1500 and made its lowest section (approximately up to the mouth of the Mura River) part of the Ottoman Empire. At least until the end of the 17th century, vast areas on both sides of the Drava River remained largely uninhabited and even deserted (Schneider-Jacoby 1996). The re-conquest of the area driven by the Habsburgs brought back agricultural activities which, however, were regionally subordinated to the military tasks the farmers had to fulfill. As a consequence, large parts of the woodland encroached on former arable land during the Ottoman rule has remained until today which is one reason for the large amount of forested areas in the lower DRB and the importance of the region for nature conservation (Sect. 3.5). It was not before the 18th century that large clearings of the forests started again under the rule of mostly Hungarian nobility.

Industrialization in the 19th century was more intensive in the western part of the DRB where first industrial activities date back even to the 17th century based on (iron) ore mining. In the Austrian part of the Austro-Hungarian Empire, economic policy was much more in favor of industry than in Hungary, where agriculture played a major role. This is the reason why the border between Hungary and Austria, which was established as early as the 11th century, further remained an important boundary in terms of land use.

Finally, in the second half of the 20th century the eastern part of the DRB belonged to states which were governed by communist regimes: Yugoslavia (areas of present-day Croatia and Slovenia) created a moderate type of communism. Hungary was situated beyond the Iron Curtain with a political and economic system orientated closely to that of the Soviet Union. From a present day's view, the retarded economic development during the Ottoman period, the focus on agriculture in the Hungarian Kingdom and finally the communist past explain the fact that the eastern part of the DRB is still less developed than the western, although since 2013 the entire DRB belongs to the EU.

In summary, the historical retrospect makes it clear that over time several political borders (Fig. 3.3) influenced the long-term development of land use according to aspects such as:

- The large amount of forests in the eastern DRB—also in areas where physical conditions would allow other types of agriculture—are the consequence (i) of the occupation and subsequent expulsion of the Ottomans and (ii) of the establishment of large estates owned by nobility in the Hungarian Kingdom.
- The transformation of the traditionally widespread heterogeneous agricultural areas to large-scale arable land with huge plots predominantly took place during the communist period, when agriculture was organized by state-owned companies. Although the ownership structure has shifted back to private enterprises, land use itself has remained similar.
- In the former Yugoslav part of the DRB collectivization of arable land took place in limited areas (especially floodplains and fluvial terraces) only. This is why the land use pattern in Slovenia and Croatia is more similar to that of Austria than of Hungary.

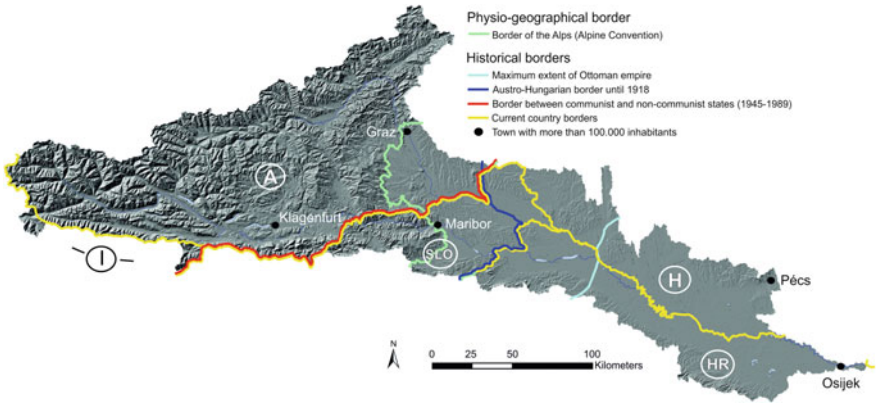

Fig. 3.3 Physical-geographical and historical boundaries (digitized manually from the maps in Bruckmüller and Hartmann 2011) influencing land use (for explanations see text)

- The difference in the economic development of the eastern and the western part of the DRB—mentioned in Sect. 3.1 and emphasized also by Sommerwerk et al. (2009)—is a consequence of the above historical processes. However, it is not directly visible in land use patterns but in environmental aspects which depend on land use (Sect. 3.5).

Summing up, the historical facts again roughly divide the DRB into a western and an eastern part. However, the dividing line is situated more to the east of the alpine boundary (Fig. 3.3).

3.3.3 Regionalization of Land Use

As already indicated, land use shows a quite clear pattern in the DRB. On the one hand, in the alpine region intensive land use is restricted due to high elevation, steep slopes, and gravitational natural hazards. The result of these restrictions is the widespread occurrence of semi-natural land use classes such as scrub and/or herbaceous vegetation associations and open spaces with little or no vegetation (Fig. 3.4), which show a pronounced concentration in the northern and western parts of the alpine region with large areas above the timberline. However, according to Table 3.1, the predominant land use type in the alpine region is forests, which also represent the most striking visual element in Fig. 3.4. Furthermore, built-up areas and agricultural land use classes are concentrated in the valley bottoms and inner-alpine basins, both limited in extension.

On the other hand, the pre-alpine part of the DRB offers favorable conditions for nearly all agricultural activities (Sect. 3.3.1)—although the relief is dominated by hills and broad valley bottoms, but not huge plains. Thus, classes indicating

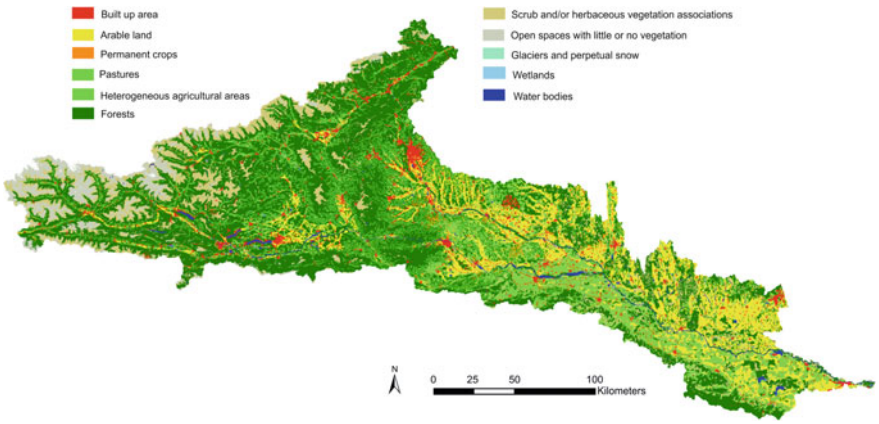

Fig. 3.4 Land use of the DRB in 2012 according to CLC. *Data source* European Environmental Agency (2017b)

agricultural activities (especially arable land and heterogeneous agricultural areas) dominate the visual appearance of Fig. 3.4. However, is has to be pointed out that in the lower eastern part of the DRB forests are also widespread (for reasons see Sect. 3.3.2). As an example of a single land use class, a closer look into forests is possible in Fig. 3.5, which shows a subdivision of forests into three subclasses. In the alpine region, coniferous forests prevail, whereas at the margin of the Alps and in their southern part mixed forests can be found. In contrast, forests in the pre-alpine region are mainly composed of deciduous trees because of the warmer

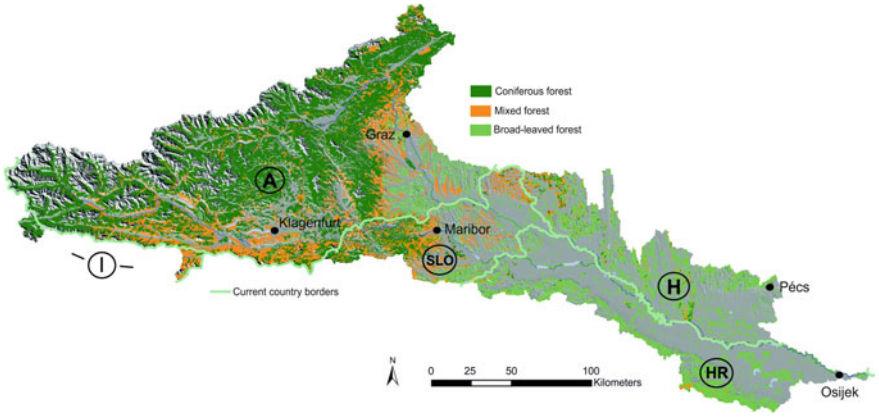

Fig. 3.5 Differentiation of forests in the DRB. *Data source* European Environmental Agency (2017b)

climatic conditions—except in some areas where mixed forests occur due to edaphic reasons.

Summing up, the land use pattern of the DRB can shortly be characterized by a western part with predominance of forests and an eastern section with predominance of agricultural areas. This distribution is the result of both physical conditions (Sect. 3.3.1) and historical processes with the ownerships of real estate's linked to them (Sect. 3.3.2).

3.4 Land Use Changes Since the Last Decade of the 20th Century

Land cover changes reflect the consumption of land of a given type and the formation of another type resulting from the use of land, from natural drivers and in combination with human drivers (Weber 2009). Changes in land use and land cover are key factors for global environmental change (Bürgi 1999). In addition, changes in technology (e.g. construction of traffic networks), culture, power, and political/economic institutions can influence land use/land cover change (Reid et al. 2000). Some major processes influencing land use (change) in the DRB have already been discussed in Sect. 3.3. Despite these changes in the natural, cultural and political framework, variations in land cover reflect a limited number of basic processes such as (Weber 2009):

- Dense and diffuse urban extension (sprawl) over agriculture and natural land;
- Urban land restructuring;
- Extension of agriculture over natural land (deforestation, drainage of wetlands, cultivation of marginal land);
- Intensification of agriculture resulting in internal conversion from pasture and mosaics to arable land;
- Crop rotations;
- Withdrawal of farming;
- Deforestation (if forest is replaced by a land use type other than agriculture);
- Forest rotations with felling and replantation;
- Extension of water bodies;
- Changes in natural land cover due to natural or multiple causes.

Land cover change identification for the DRB as presented in Table 3.2 and Fig. 3.6 is based on the CLC datasets mentioned in Sect. 3.2. Because of methodological restrictions changes in land use are only mapped if they affect an

Table 3.2 Absolute and relative areas of land use classes in the DRB in 1990, 2000, 2006 and 2012

	Land use class	1990		2000		2006		2012	
		km^2	%	km^2	%	km^2	%	km^2	%
1	Built-up area	1,387.89	3.49	1,490.42	3.75	1,603.18	4.03	1,658.27	4.17
2	Arable land	5,378.95	13.53	5,484.59	13.80	5,604.96	14.10	5,520.69	13.89
3	Permanent crops	215.24	0.54	218.06	0.55	181.63	0.46	178.35	0.45
4	Pastures	3,168.32	7.97	3,028.86	7.62	2,925.13	7.36	2,915.63	7.33
5	Heterogeneous agricultural areas	5,762.18	14.49	5,745.57	14.45	5,654.66	14.22	5,618.66	14.13
6	Forests	18,256.34	45.92	18,332.15	46.11	18,219.61	45.83	18,107.57	45.55
7	Scrub and/or herbaceous vegetation associations	3,578.23	9.00	3,423.16	8.61	3,531.57	8.88	3,719.09	9.35
8	Open spaces with little or no vegetation	1,442.48	3.63	1,516.06	3.81	1,531.44	3.85	1,536.98	3.87
9	Glaciers and perpetual snow	134.82	0.34	98.35	0.25	83.02	0.21	77.56	0.20
10	Wetlands	94.65	0.24	79.15	0.20	76.38	0.19	76.77	0.19
11	Water bodies	336.28	0.85	339.01	0.85	343.80	0.86	345.81	0.87
	Total	39,755.38	100.00	39,755.38	100.00	39,755.38	100.00	39,755.38	100.00

According to CLC, *data source* European Environmental Agency (2017b)

area larger than 5 ha and with a width of more than 100 m. Figure 3.6 shows the areas in which changes of the specific land use classes occurred.

An area of 1,400 km^2 of land cover change was identified for the period 1990–2012 in the DRB. According to the defined classes, the following statements can be made:

- Built-up areas show an increase from 1990 to 2012 by 20%—with a striking difference between the alpine (+30%) and the pre-alpine region (+12%).
- Arable land (slight increase) and heterogeneous agricultural areas (slight decrease) in total are quite stable land use classes in the entire DRB catchment—though an increase of arable land (24%) in the alpine region can be recognized.
- Fruit tree/berry plantation and vineyard areas are decreasing in each period from 1990 to 2012 (in total −37%), whereas in the alpine area this land use class has remained stable (due to the predominance of fruit trees). In general it is remarkable, that large areas with fruit trees (e.g. in Eastern Styria) are not recorded in the CORINE data.
- In the alpine region the areal extent of pastures, which are located in the alpine foot zone and on clearings at moderate elevations, is stable whereas the pre-alpine pastures show fluctuations with an overall decrease of 20%.
- Forests (46% of DRB) show no or only small changes in their spatial extent from 1990 to 2012. Deciduous and coniferous forests slightly increased whereas mixed forests have decreased.
- Open spaces with little or no vegetation (about 4% of DRB) are dominant in the alpine region (slight increase of 7%); this land use class mainly comprises bare rocks and sparsely vegetated areas above the timberline in the high mountains.
- The summit zones of high mountains show glaciers and perpetual snow with a remarkable decrease of 42% (see below).
- From 1990 to 2012 wetlands (0.2% of the DRB) decreased by 20%, whereas water bodies (water courses: 0.6% and water bodies: 4.5%) slightly increased.

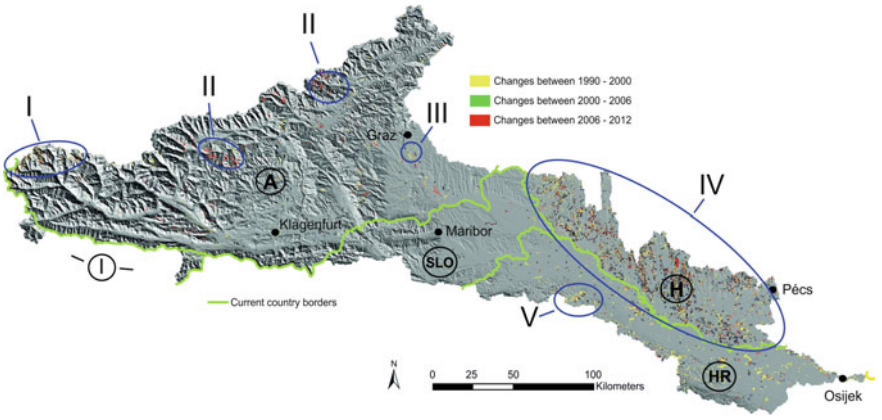

Fig. 3.6 Land use change in the DRB 1990–2012. *Data source* European Environmental Agency (2017b)

In Fig. 3.6, some exemplary areas with striking changes of land use are marked (I–V). They have been chosen because they are conspicuous in Fig. 3.6 and different processes underlie the changes:

- Area I (High Tauern Range) is primarily affected by changes in the land use class glaciers and perpetual snow. This is a consequence of the ongoing accelerated glacier retreat caused by global warming.
- Area II (Low Tauern Range) consists of two sub-areas in which the land use class forests significantly changed. As in area I, there was no deliberate change in land use, but some heavy winter storm events (e.g. "Paula" in January 2008) cleared large tracts of forest. Because all the areas affected are still characterized by intensive forestry, this is, strictly speaking, an example of land *cover* but not land *use* change.
- Area III documents changes in the vicinity south of Graz, the largest of the few large cities in the DRB. Detected changes here mainly refer to the land use class built-up areas and were caused by the expansion of gravel pits and settlements. Hence, this is an example of changes connected with urban sprawl.
- Area IV represents intensive changes in the land use classes linked to agriculture (above all arable land and heterogeneous agricultural areas). The area comprises the entire Hungarian part of the DRB and the detected changes can be interpreted as the consequences of the agricultural transformation because of the political changes since 1989.
- Area V appears to be quite similar to area IV with changes referring to agricultural land use. However, the areas affected are by far smaller than in Hungary and the transformation mainly occurred in the period 1990–2000.

All in all, from a regional point of view the observed changes are concentrated in specific parts of the DRB. The examples above have shown that natural (areas I and II) as well as human processes can be the reason for changes. However, it remains open to which extent errors in the CLC dataset influence the picture. In any case, land use seems to have changed most dynamically in Hungary whereas in Slovenia only very small areas were affected.

3.5 Land Use and Environmental Problems

Land use is a key factor in environmental problems. In this study, we (i) shortly discuss the influence of land use activities on the environmental quality of the DRB and (ii) take an exemplary look into areas protected within the EU framework of Natura 2000. In order to check the impact of human activities on a Central European scale, the study of Nefedova et al. (1992) is a valuable source. The maps provided by them cover the entire DRB (except of its tiny Italian section) and show that—in accordance with our results—the DRB is in its eastern part characterized by high intensity of agricultural land use whereas there are only a few industrial

locations with a significant emission potential of pollutants (particularly in the upper Mura catchment, Maribor and Dravsko polje, Pécs, Osijek). To a large extent, this is due to the fact that there are no major urban agglomerations in the DRB—only 5 cities exceed 100,000 inhabitants (with even the largest, Graz, remains below 300,000). Hence, air, water, and soil quality is better than in most other second-order subcatchments of the Danube (Nefedova et al. 1992). However, this does not mean that there are no environmental problems, but they are not as urgent as is many other regions. Considering the Drava River itself, Sommerwerk et al. (2009) address a set of environmental problems ranging from the negative influence of large dams for power production (their number of 49 is the highest one of all subcatchments of the Danube, see Chap. 9 in this volume) to the sewage input from cities in the transformation countries.

3.6 Land Use and Nature Conservation

Our results show a high percentage of land use classes which can be considered natural and seminatural (classes 6–11 in Table 3.2 together covered 60% of the DRB in 2012!). This means that nearly no pollutants are emitted from them. Thus, it is to be expected that protected areas have a large extent in the DRB (including Natura 2000 areas—Fig. 3.7). Natura 2000 is a key instrument to protect biodiversity in the EU. It is an ecological network of protected areas, set up to ensure the survival of the most valuable species and habitats in Europe, based on the 1979 Birds Directive and the 1992 Habitats Directive (European Environmental Agency 2017b).

Natura 2000 areas cover 23.2% of the DRB (Table 3.3). The protected areas show concentrations (i) in the high mountains of the west and north of the alpine

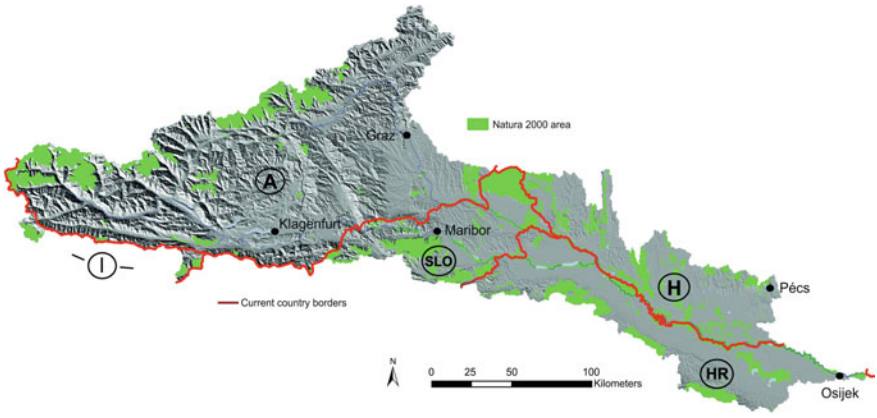

Fig. 3.7 Natura 2000 areas in the DRB. *Data source* European Environmental Agency (2017b)

Table 3.3 Natura 2000 areas in the DRB by countries and areas of the countries within the DRB

Country	Natura 2000 area		Country area belonging to DRB	
	km^2	%	km^2	%
Austria	2,614.37	28.3	22,163.11	55.8
Croatia	2,558.07	27.7	6,645.86	16.7
Hungary	1,683.02	18.2	5,903.17	14.8
Italy	182.33	2.0	363.05	0.9
Slovenia	2,205.15	23.8	4,680.19	11.8
Total	9,242.94	100.0	39,755.38	100.0

Data source European Environmental Agency (2017b)

region and (ii) in the pre-alpine region. In the high mountains, the widespread areas with little or no human impact are of course the basis for the protection status (e.g. High Tauern National Park, Austria). This also applies to the floodplain forests of the pre-alpine region (e.g. Duna-Drava National Park, Hungary), forming a corridor of valuable ecosystems of European importance along the Mura and Drava (Schneider-Jacoby 1996, 15 and Chap. 20). However, one can find protected areas also in agricultural regions as far as the intensity of land use is moderate (e.g. Krajinski park Goričko, Slovenia)—here the predominance of the land use class heterogeneous agricultural areas gives place to a broad variety of ecosystems with high biodiversity. However, the distribution of protected areas in Fig. 3.7 does not so much reflect land use patterns, but rather the environmental policies of the single states (and federal countries in Austria)—comparing the percentage of the country and the protected areas (Table 3.3) gives a hint on the ambitions of environmental policy in the individual countries.

3.7 Conclusions

From a methodical point of view, our study has some limitations because we used a single dataset. For the comparability of the data between countries, however, this was inevitable. Thus, the statements derived from our data are as good as the data are. In an overall perspective data quality is sufficient at least at the scale of the entire DRB. But even at this scale, some artifacts, classification mistakes or simply misinterpretations are evident. For instance, in the Prekmurje region of Slovenia built-up areas are shown in Fig. 3.4 where they definitely do not exist—this area is part of the Goričko Natura 2000 site (Sect. 3.5)! These errors could be corrected in a regional analysis whereas in the present study this was not possible.

Based on a multitemporal analysis of CLC data a good overview of land use pattern and its recent change in the DRB could be given. Thereby the presented data are in good agreement with those from Sommerwerk (2009), discussed in Sect. 3.1. Land use in the DRB is dominated by forests (2012: 46%), due both to natural

conditions (especially in the alpine region) and to the historical development (especially in the pre-alpine region). Regionalizing the DRB shows the most pronounced differences between the west and the east (with Slovenia having an intermediate position):

- The western part is naturally characterized by alpine conditions and historically by being part of Austria. In terms of recent land use (changes), this means dynamic economy and high environmental pressures, but also an early establishment of sustainable land use directives and high environmental standards.
- The eastern part belongs to the pre-alpine region and shared its historical development with Hungary. In terms of land use (changes) this means an economic concentration on agriculture, under the communist regime a retarded economic development with low environmental standards and a currently still ongoing transformation process.

Looking at the DRB in its entirety, it can be claimed that still large areas have remained in a status with only moderate human impact proved by a high percentage of high-grade protected areas (Sect. 3.5). However, environmental protection as part of sustainable development is a highly challenging task for the future. Concerning the river itself, the floodplains are still endangered by hydropower projects, gravel extraction and navigation (20% of the river length is navigable) (Sommerwerk et al. 2009) although there are several sustainable initiatives like Drava Life (2017) or a projected biosphere reserve (for details see other contributions in this volume). Concerning the entire DRB catchment, there are some non-negligible problems the solution of which also impacts the entire Danube River Basin (Sommerwerk et al. 2010). However, improving the current environmental status of the DRB seems to be much easier than in many other European river catchments.

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