TERRACED LANDSCAPES

ANTON MELIK GEOGRAPHICAL INSTITUTE **ZRC SAZU**

TERRACED LANDSCAPES

COMMEMORATING
SEVENTY YEARS
OF THE ANTON MELIK GEOGRAPHICAL INSTITUTE
ZRC SAZU

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AUTHORS

TERRACED LANDSCAPES

Project leader: Drago Kladnik
Editors: Drago Perko, Rok Ciglič, Matjaž Geršič, Drago Kladnik
Reviewers: Boštjan Kerbler, Ana Vovk Korže
Chapter authors: Terraced Landscapes and the Honghe Declaration (Drago Kladnik), Terraced Landscapes around the World (Matjaž Geršič, Drago Kladnik, Peter Kumer, Matija Zorn), Terraced Landscapes in Europe (Drago Kladnik, Blaž Komac, Matija Zorn), Terraced Landscapes in Slovenia (Drago Kladnik, Drago Perko), Mediterranean Slovenia (Primož Pipan, Mateja Šmid Hribar, Maja Topole), Dinaric Slovenia (Matej Gabrovec, Jernej Tiran), Alpine Slovenia (Matjaž Geršič, Primož Pipan, Peter Repolusk, Mimi Urbanc), Pannonian Slovenia (Primož Pipan, Peter Repolusk), Nonagricultural Terraces Landscapes (Mateja Ferk, Maja Topole
Cartography by: Manca Vovlk Bahun, Rok Ciglič, Matjaž Geršič
LIDAR images by: Žiga Kokalj
Photos by: Matevž Lenarčič, Oren Ackermann, Goran Andlar, Lemonakis Antonis, Kosala Bandara, Mike Barratt, John Bill, Oksana Bjelikova, Robert Brglez, Sebastien Burel, Cao Cat, Aljaž Celarc, Hung Chun Chin, Truong Cong Hiep, John Copland, Renate Dodell, Matthew Dixon, Bojan Erhartič, Luka Esenko, Marisa Estvill, Mateja Ferk, Brian Fisk, Flickr, Jerneja Fridl, Filip Fuxa, Christopher Gardiner, Matjaž Geršič, Hoang Giang Hai, Rostislav Glinskij, Jevgenij Gorodeckij, Vidu Gunaratna, Jorg Hackemann, Michael Hero, Israel Hervas Bengochea, Jean Marie Hullot, Pavel Iljuhin, Attila Jandi, Dennis Jarvis, Ron Kacmarcik, Pawel Kazmierczak, Sandi Kelnerič, Drago Kladnik, Blaž Komac, Karol Kozlowski, Ram Kumar, Peter Kumer, Yongyut Kumsri, Wojciech Lisinski, Igor Maher, Ehtiram Mammadov, Dobrin Minkov, Sean Munson, NASA, Tomihiro Ohsumi, Jaka Ortar, Sean Pavone, Miha Pavšek, Vadim Petrakov, Dmitrij Pičugin, Primož Pipan, Daniel Prudek, Tim Roberts, Denis Rozan, Nicram Sabod, Witchaphon Saeng-Aram, Shutterstock, Gwendolyn Stansbury, Laszlo Szirtesi, Valerij Šanin, Kyle Taylor, Sam Thompson, Jernej Tiran, Kenny Tong, Maja Topole, Jimmy Tran, Claudio Vidri, Klara Vlasakova, Ewelina Wachala, Wallup.net, Peter Wollinga, Wolfgang Zwanger
Translated by: DEKS. d. o. o.
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SEVENTY TERRACED STEPS OF THE GEOGRAPHICAL INSTITUTE

The Anton Melik Geographical Institute at the Research Center of the Slovenian Academy of Sciences and Arts has commemorated its major anniversaries in a working manner for some time. In 2016 the institute celebrated its seventieth anniversary, and its birthday gift for both you and us is the volume *Terraced Landscapes*. This book is the fruit of a three-year research project co-financed by the Slovenian Research Agency and the Slovenian Academy of Sciences and Arts.

Terraces are made of steps from the ground to a peak that increase the value of a terraced landscape, and it is through similar steps in terms of time, quantity, and quality that our institute has also ascended, enriching the Slovenian body of research.

The institute was created on May 7th, 1946, when the government of the People's Republic of Slovenia issued a decree founding the institute's oldest unit, the Geography Museum. That same year, the Academy of Sciences and Arts allocated the first funding for the institute's operations: for measuring the Triglav Glacier. The institute continues to carry this out every year, making this study the oldest continuous Slovenian research project of all. In 1947 the institute already had its own item in the budget for the People's Republic of Slovenia, and in 1948 the assembly of the Academy of Sciences and Arts confirmed the charter of the Geographical Institute, which was prepared by the man behind its founding, academy member Anton Melik, whose name the institute has borne since 1976. In 1981 the institute was incorporated into the Research Center of the Slovenian Academy of Sciences and Arts, and in 2002 it was joined by the Institute of Geography, which was founded in 1962.

In the twenty-first century, the institute includes departments of physical geography, human geography, regional geography, natural hazards, environmental protection, geographic information systems, and thematic cartography, as well as a geography library and a geography museum. The institute's researchers primarily study Slovenia and its regions, and they prepare seminal geographical works about Slovenia. We participate in many Slovenian and international projects, hold conferences, train young researchers, and take part in researcher exchanges with many countries. The institute is the seat of the Slovene Governmental Commission for the Standardization of Geographical Names.

Since it was founded, the institute has been distinguished by many publications. It issues the journal *Acta geographica Slovenica / Geografski zbornik* (Geographical Proceedings) and the research volume series *Geografija Slovenije* (Geography of Slovenia) and *Georitem* (Georhythm). In even years the book series *GIS v Sloveniji* (GIS in Slovenia) is published, in odd years the book series *Regionalni razvoj* (Regional Development), and every third year the book series *Naravne nesreče* (Natural Disasters). In 2006 the institute celebrated its sixtieth anniversary by publishing a facsimile of *Atlant*, the first world atlas in Slovenian. The reissue of *Atlant* was important not only for the geographical institute but also for the entire Research Center of the Slovenian Academy of Sciences and Arts because *Atlant* features exactly what defines this organization comprised of eighteen research institutes: the connection of humanities, natural science, social science, and technical disciplines into a new whole, which is reflected in preserving Slovenia's natural and cultural heritage and in the popularization of science. This volume is the result of and an enrichment of scholarship in cartography, geography, Slovenian studies, and history. Despite first impressions, completely different disciplines were involved in creating the maps, which are scientific, artistic, and technological accomplishments.

It is not surprising that the institute's anniversaries are celebrated by issuing such important volumes, atlases, and maps, because it is the cradle of Slovenian institutional cartography. The assembly of the Slovenian Academy of Sciences and Arts established the Cartography Institute on February 7th, 1952, now named the Department of Thematic Cartography. The institute achieved a global profile by preparing certain seminal cartographic works about Slovenia, such as the large *Geografski atlas Slovenije* (Geographic Atlas of Slovenia, 1998), the extensive volume *Slovenija – pokrajine in ljudje* (Slovenia: Landscapes and People, 1998), *Nacionalni atlas Slovenije / National Atlas of Slovenia* (2001, in Slovenian and English to mark the tenth anniversary of Slovenian independence), a map of Slovenia for the National Geographic Society (2006), the first *Popisni atlas Slovenije* (Census Atlas of Slovenia, 2007), and the English-language atlas *Slovenia in Focus*, which was issued on January 1st, 2008, when Slovenia assumed the presidency of the European Union. A European dimension was also involved in publishing a facsimile of Gaetan Palma's map of the Illyrian Provinces, which historically, geographically, and cartographically connects Slovenia with France. The publication of this map on the bicentennial of the Illyrian provinces in 2012 marked the sixtieth anniversary of the institute's cartography department.

The book *Terraced Landscapes* not only has a European dimension, but also presents agricultural and other terraces around the world and compares them with those in Slovenia. Throughout the world, generations of people have invested enormous labor in constructing agricultural terraces, through which they completely changed the appearance of the landscape. In a similar manner, the former and current researchers at the geographical institute have built up a new terraced step of geographical knowledge every year since the institute's modest beginnings. Now, from the seventieth step of this terrace, we can look with satisfaction at the lower levels and our past achievements, and look forward with confidence to new and even higher levels on this terrace.

Drago Perko
Director

TERRACED LANDSCAPES AND THE HONGHE DECLARATION

Terraced landscapes are cultural landscapes with a special value. Their agricultural terraces provide food and also have priceless scientific, cultural, historical. ecological, aesthetic, and even psychological, philosophical, and religious value. They form a unique agricultural and ecological system that can be found throughout the world. In some developed civilizations they were created in an organized manner over millennia, and in others they arose completely spontaneously as people adapted to natural conditions and improved their opportunities to make a living. They therefore reflect a harmony between man and nature, and in many cases also between people themselves.

Agricultural terraces are one of the most distinctive landscape elements. They differ with regard to when they were created, natural conditions, configuration, purpose, land use, intensity of use, ownership, and accessibility. Slovenia is among the few places in Europe with agricultural terraces throughout the entire country. In places they are so important that one can speak of terraced landscapes, and elsewhere they are less distinct and can only be detected through detailed studies.

The study of terraced landscapes intensified after 2000. Their international recognition as exceptional landscape systems reached an apex with the first two world conferences on terraced landscapes. The first, held in China in November 2010, saw the founding of the International Terraced Landscapes Alliance (ITLA) and the adoption of the Honghe Declaration on the protection and development of terraces. The second conference was held in May 2014 in Peru.

Traditional terraces are usually associated with subsistence farming because market production on them is too costly. Because of social restratification and lack of adaption to mechanical cultivation, they are subject to large-scale abandonment, overgrowth, and deterioration, and traditional terraced landscapes are becoming neglected. Unmaintained and unregulated terraces on steep slopes are threatened by slumping and landslides.

The history of terracing is still insufficiently researched, although such practices have been applied in various parts of the world independently of one another in order to improve farming. Terracing as an agricultural system is known from the Neolithic onward (Agnoletti et al. 2015), and there are terraces in Peru over four thousand years old (Hamilton, Hamilton and Chambers 1943). The terraced Hanging Gardens of Babylon from the seventh century BC, one of the Seven Wonders of the Ancient World, were described by the Greek geographer Strabo in the first century BC. He wrote that King Nebuchadnezzar II had the gardens built to ease the homesickness of his wife, who missed the greenery of her homeland (Rivera 2012).

People cut agricultural terraces manually or mechanically into slopes to obtain farmland, facilitate and intensify farming, reduce soil erosion, increase and retain soil moisture, and, in areas with irrigation farming, allow gravitational irrigation (Kladnik, Lovrenčak and Orožen Adamič 2005). Terraces are composed of level or slightly inclined platforms of varying width intended for cultivation and steeper terrace slopes of varying height. The steeper the terraced slope is, the narrower are the terrace platforms. Cultivating terraces requires less work than cultivating steep slopes that are not terraced. In many places, including Slovenia, terraces were unintentionally created through long-term plowing of the land in the same direction, whereby the leveling of platforms and creation of slopes gradually created steps along the slope.

There are two basic types of agricultural terraces:

- Step-like dry terraces with variously inclined slopes made of earth or stone, or reinforced with a combination of these, running along the contour lines; and
- Irrigated terraces with leveled terrace platforms and elevated slopes or shoulder bunds on the outside to retain irrigation water.

The term *terrace* has several meanings. For example, in geomorphology there are river terraces and submarine terraces, and architecture uses the term to refer to a paved area on part of a building or next to it (Slovene Literary Language Dictionary 2010). In geography, agricultural terraces may also be referred to as *cultivated terraces* because they are intended for growing crops, and in the broader sense also as *manmade terraces* because they were not made by nature, but by man.

The aesthetic value of terraced landscapes is defined by the repeating pattern of terrace platforms and slopes, or the geometrization of the slope. Such a landscape is attractive and orderly not only in the spring, summer, and fall, when the lushness and color of the vegetation attracts the attention of locals and visitors, but also in the winter, when the terraced landscape pattern becomes even more distinct because of the snow melted away from the terrace slopes (Ažman Momirski and Radikon 2008). Thus, terraced landscapes are among the world's most picturesque landscapes found on the internet (e.g., Amazing Satellite … 2016). The attractiveness of terraced landscapes is shown by the list of eleven »incredible terrace fields« on the internet (11 Incredible … 2014), which includes five terraced regions in Peru (Choquequirao, Machu Picchu, Ollantaytambo, Pisac, and the Maras Salt Pans), two in China (the Longji and Hani terraces), and one each from Vietnam (near the town of Sa Pa), the Philippines (the Banaue Rice Terraces), Indonesia (Bali), and Portugal (the Douro Valley). A similar list of seventeen »tremendous terraced rice fields« (17 Tremendous … 2011) includes, in addition to Asian sites (in the Philippines, China, Japan, India, and Nepal), only one non-Asian one, the steep terraced slope at Machu Picchu. A list of the top ten »destinations for rice terraces« (Top 10 Destinations …), in addition to Asian rice paddies in Nepal, China, the Philippines, Indonesia, Bhutan, India, and Vietnam, also includes terraced landscapes in eastern Africa (Ruanda, Burundi, and Uganda) and Morocco, and also mentions terraces in Iran, Iraq, Chile, Mexico, Fiji, Korea, Japan, Yemen, Madagascar, Swaziland, Sri Lanka, and southeast Asia in general.

This shows that globally the best-known terraces are irrigated terraces, intended primarily for

◀ Up & left: Photogenic terraced landscapes attract admirers from near and far. LUKA ESENKO
Up & right: A Mediterranean terraced landscape as depicted by the German surrealist painter Mati Klarwein. (1932–2002) (Landscape … 1985–1987).
Down & left:Terraced rice paddies in northern Vietnam, where members of the Hmong ethnic minority live. HOANG GIANG HAI, SHUTTERSTOCK
Down & right:An Inca plan of an irrigation system with terraces, water canals, and basins carved on a monolith in Peru. DRAGO KLADNIK

rice cultivation, although European terraced vineyard landscapes, and not least of all dry terraces intended for field crops, which predominate in Slovenia, can be equally picturesque and wonderfully complement the landscape character. Marjan Garbajs's aerial photo of the terraced Brkini Ridge at Ostrožno Brdo is well known. Because of its aesthetic impact, it has appeared in several books (e.g., Perko and Orožen Adamič 1998; Luthar et al. 2008; Križaj Smrdel 2010b) and articles (e.g., Kladnik, Perko and Urbanc 2009).

In this volume we wish to present terraced landscapes in images and text in all of their landscape diversity and attractiveness. We also draw attention to the exceptional character and attraction of nonagricultural terraced landscapes that were shaped by nature and man. We first present agricultural terraces around the world and in Europe, and then Slovenian terraced landscapes divided into four main landscape types, within which sample areas in selected settlements are discussed in greater detail as representatives of individual types.

The text and photos are complemented by diagrams that present the basic characteristics of exclusively terraced land determined using GIS tools. To analyze the landscapes, we used a 12.5 m digital elevation model (Digitalni model višin 2009–2011), and for the analysis of sample areas a 1 m model obtained through laser scanning data.

When systematically mapped the terraced areas, we digitized the terraced areas visible on digital orthophotos (DOF; Digitalni … 2011–2015). We eliminated level areas (up to 5° or 8.75%), very steep areas (over 50° or 119.2%), water areas, and built-up land. We also used 1:5,000 base topographic maps (1:10,000 in mountainous areas), on which agricultural terraces are marked with a distinctive topographic symbol (Basic Tophographic … 1993–1995).

For analyzing current land use, we relied on data from 2015. Computer interpretation of orthophotos was complemented by field inspections and measurements. For analyzing past land use, we used the 1:2,880 Franciscan cadastral maps from 1817–1828. For seven sample settlements, these are kept by the Archives of the Republic of Slovenia in Ljubljana (sheets SI AS 176–179), and the maps for the sample settlement of Krkavče are kept by the State Archive in Trieste (sheet IT AST 179).

The data on terraced areas are not complete. It is difficult to use remote sensing to capture areas with the lowest level of terracing with indistinct terrace slopes and abandoned terraces overgrown with trees. More is possible with LIDAR (Light Detection and Ranging), which was unfortunately available too late for the entire territory of Slovenia, and so its advantages could only be tested for the sample areas. Using LIDAR, which precisely shows the surface configuration even below vegetation cover, we also prepared three-dimensional representations of terraced land in the sample settlements.

DRAGO KLADNIK

Participants at the first world conference on terraced landscapes in Mengzi during adoption of the Honghe Declaration.

Global Declaration on Protection and Development of Terraces

(Drafted by Prof. Shi Junchao, Peters and Junchao 2012, 8–9; Internet 2)

November 11th to 15th, the most beautiful and romantic season for Hani terraces in Honghe, we, representatives and scholars from 16 countries, terraces farmers and international communities including UNESCO, FAO, Convention on Wetlands of International Organization as well as U.S. Environmental Department, will gather together in the capital city of Honghe Hani and Yi People's Autonomous Prefecture to held the first terraces conference, explore ways and methods to protection and development of global terraces civilization.

All participants of scholars, farmers and international organizations here jointly declare:

Terraces, as an agriculture ecological system wide spread around the world, is the great civilization creation in the thousands years of history.

1) Terraces has included numerous human hardworking and creative wisdom, and fully reflected the concept of high level integration of human and the nature, safeguarding bio-diversity and culture-diversity, providing quality ecological serving function characterized with sustainable development, therefore, is both the symbol and pride of all terraces nationalities and state spiritual civilization. For thousands of years, terraces is not only the cornerstone to build human civilization, but also feed huge population in the world; the terraces not only satisfied people's material needs, but also is the home garden of their spiritual belief.
2) However, for the last half century, globalization and economic integration forcefully impacted on the terraces civilization, imposed most severe challenges for this ancient civilization. Many terraces has been abandoned, and many culture has been listed as endangered to extinction. In such a critical moment, how to protect terraces tradition and develop terraces future have become an era proposition.
3) Protection and development of terraces is the common responsibility of the whole society: the governments undertake management responsibility, scholars in charge of important research work, farmers responsible for the direct safeguard and protection, enterprises assume ecological-friendly operation based on protection conscience, while social societies shouldered ethical responsibility of participation and support.
4) Terraces civilization is an all-information value system, in addition to provide survival food, it also valued in areas of science, culture, history, philosophy, religion, ecology and aesthetics, therefore, can not be substituted by any civilization.
5) What is worth noting is that: the nature of terraces civilization lies in its affinity, that is affinity between human and the nature, affinity among human beings. Affinity of terraces civilization is strong enough to moderate any conflicts and contradictions occurred among different ethnic groups, different countries and civilizations, therefore, this ancient terraces civilization possess great modern significance and long standing future significance.
6) Protection and development of terraces civilization need construction of scientific and complete management organization and relevant professional consultant organization. Policies applied to terraces should prioritize protection, followed by reasonable exploration based on scientific utilization and sustainability.

All protections and utilizations activities should also be responsible for the history, with process from planning to implementation, fully take scholars and experts opinions into consideration, in particular, respect farmer's free choice. At present, the most urgent task is to acquire a complete new and scientific understanding of the value of terraces civilization, demolish either abandon or over exploration, based on respecting tradition, reconstruct terraces with modern technology and method in order to ensure healthy development of terraces civilization.

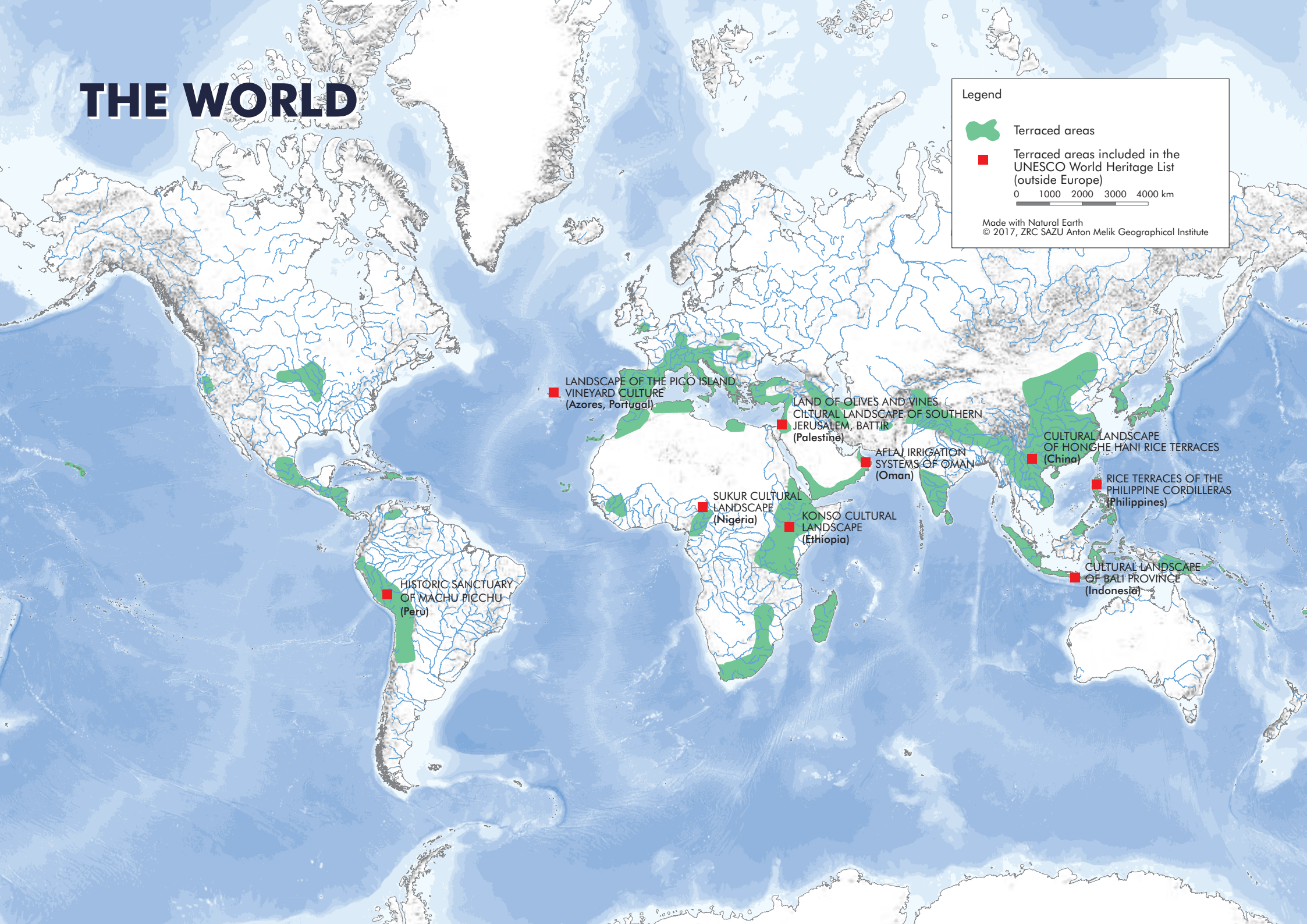
What will be the future of terraces rested upon our understanding, in particular, what will we do now.

We wish through our joint efforts, terraces will last forever, benefiting our future generations.

November 15th, 2010

Mengzi, Honghe Hani and Yi Autonomous Prefecture, Yunnan, China

THE WORLD


Legend
Terraced areas
Terraced areas included in the UNESCO World Heritage List (outside Europe)
0 1000 2000 3000 4000 km
Made with Natural Earth
© 2017, ZRC SAZU Anton Melik Geographical Institute
LANDSCAPE OF THE PICO ISLAND VINEYARD CULTURE (Azores, Portugal)
LAND OF OLIVES AND VINES CULTURAL LANDSCAPE OF SOUTHERN JERUSALEM, BATTIR (Palestine)
AFLAJ IRRIGATION SYSTEMS OF OMAN (Oman)
CULTURAL LANDSCAPE OF HONGHE HANI RICE TERRACES (China)
RICE TERRACES OF THE PHILIPPINE CORDILLERAS (Philippines)
SUKUR CULTURAL LANDSCAPE (Nigeria)
KONSO CULTURAL LANDSCAPE (Ethiopia)
CULTURAL LANDSCAPE OF BALI PROVINCE (Indonesia)
HISTORIC SANCTUARY OF MACHU PICCHU (Peru)

As unique agricultural, social, and ecological systems, terraced landscapes are known in various forms around the world. They arose over long millennia, generally in developed civilizations, in environments that had little or no connection with one another. They reflect a harmony between man and nature, and in many places also coexistence between people. Because of many millennia of development, they also represent a complex whole of priceless cultural, historical, ecological, aesthetic, psychological, philosophical, literary, and not least of all religious values, and hence they are naturally also a source of great research interest.

Agricultural terraces are important for food production, water management, and maintaining terrain stability and biodiversity. From the global perspective, two basic types are distinguished: irrigated and dry terraces. The first are intended for growing crops that require a lot of water, the most typical being rice. Gravitation causes water to flow from terrace to terrace, whereby very precise agreements are established between neighbors for distributing the quantity of water available, with very sophisticated techniques used for directing its flow. Dry terraces retain part of the water runoff from precipitation and also make farming possible in many places where insufficient rainfall would otherwise prevent it (Rivera 2012). UNESCO has also recognized terraces as landscapes with exceptional value that must be protected. Its world heritage list currently includes 1,031 units, of which 143 are cultural landscapes, among which seven are clearly defined as terraced landscapes, eight have terracing specified as an important part of their protection, and seven have terracing identified as a distinct component (UNESCO … 2015). In recent years the number of such heritage units has grown quickly.

◀ Terraced landscape areas on Earth.

TRUONG CONG HIEP, SHUTTERSTOCK

Rice ripening on terraces in Lào Cai Province in northern Vietnam.

DRAGO KLADNIK

High stone risers of Inca terraces, still partially cultivated, in Peru's Andamarca District.

EASTERN AND SOUTHEAST ASIA

PAVEL ILJUHIN, SHUTTERSTOCK

Rice terraces in souteastern Guizhou, near the Zhaoxing, one of the largest Dong minority villages in China.

HUNG CHUN CHIN, SHUTTERSTOCK

Planting rice on terraces in Longsheng Autonomous County in southern China.

PETER WOLLINGA, SHUTTERSTOCK

A sunny branching terraced landscape with ripening rice in China.

SHUTTERSTOCK

Terraces on red soil in the Dongchuan District in the north of China's Yunnan Province.

◄ A panoramic view of endless Hani terraces prepared for sowing rice in Yuanyang County in extreme southern China. SHUTTERSTOCK

DENIS ROZAN, SHUTTERSTOCK

A photogenic terraced landscape in northern Vietnam; slumps are frequent because of the steep slopes.

MICHAEL HERO, SHUTTERSTOCK

Overlap of two seasons in rice cultivation: preparing paddies before sowing and greening during the growth phase.

CAO CAT, SHUTTERSTOCK

A terraced fan in Vietnam's Yên Bái Province along the Red River.

JIMMY TRAN, SHUTTERSTOCK

The terraced landscape in Yên Bái Province is among the most attractive cultivated landscapes in the world.

◀ Terraced rice paddies before harvest in the Mù Cang Chải District of Yên Bái Province in mountainous northern Vietnam. SHUTTERSTOCK

SHUTTERSTOCK

Small terraces, where only manual cultivation is possible, prevail in Ishikawa Prefecture.

SHUTTERSTOCK

Rice paddies with risers overgrown with red spider lily in Nara Prefecture in southern Honshu.

SEAN PAVONE, SHUTTERSTOCK

A terraced landscape near Kumano in Mie Prefecture on Honshu.

TOMOHIRO OHSUMI, SHUTTERSTOCK

Terraces adapted for mechanical cultivation near the town of Yabu northwest of Osaka.

◄ In Japan, the land of the rising sun, terraces are also receiving the light of the setting sun, which is common in Ishikawa Prefecture in western Honshu above the coast of the Sea of Japan. SHUTTERSTOCK

Most of eastern and southeast Asia together with the Indian subcontinent or southern Asia comprise monsoon Asia, which acquired its name from the characteristic monsoon climate with annual alternation of dry winter winds that blow from the land to the sea and humid summer winds that blow from the sea to the land, bringing with them heavy rainfall. Eastern Asia or the Far East comprises China, North and South Korea, and Japan, which are in a temperate and subtropical zone, and southeast Asia comprises Myanmar, Thailand, Laos, Cambodia, Vietnam, Malaysia, Indonesia, and the Philippines, which are mostly tropical and partially subtropical (Ilešič 1969). At the global level, eastern and southeast Asia have the most agricultural terraces of all.

The earliest reliable dating of terraces goes back to between 2500 and 3000 BC, and some surmise (e.g., Sandor 1998) that terraces are even considerably older. The first ones may have been created in China and the Korean peninsula around 3500 BC. They are praised in the *Classic of Poetry*, the oldest collection of ancient Chinese poetry, in which they are referred to as fields on slopes (Zhiqiong 2012). Many terraced areas are now protected as cultural monuments and are important tourist sites (Settele 2012). Some of them are cultural landscapes with intensive agriculture, or have been abandoned and are now archaeological sites (Asian Rice … 1995).

In eastern and southeast Asia, the majority of agricultural terraces are in hilly and mountainous areas (Asian Rice … 1995). In China, most of them are found in the center and south of the wetter eastern part of the country, and fewer in the interior and in the north. On the Korean peninsula, South Korea is more terraced, and in Japan the islands of Honshu, Kyushu, and Shikoku. In the Philippines and

SHUTTERSTOCK

Recently sowed rice on regularly laid out terraces in the northern hilly part of Thailand, in the Chiang Mai area.

SHUTTERSTOCK

Endless rice terraces in northern Thailand.

WITCHAPHON SAENG-ARAM, SHUTTERSTOCK

A terraced tea plantation on the slope of Doi Ang Khang (1,928 m), a mountain in Thailand.

SHUTTERSTOCK

Intensively cultivated densely terraced fields in Thailand.

WITCHAPHON SAENG-ARAM, SHUTTERSTOCK

Terraced strawberry fields in extreme northern Thailand, near the border with Myanmar.

Varied cultivated terraces on the Dieng Plateau in central Java, Indonesia's most densely populated island, where the high elevation makes it too cold to cultivate paddy rice. SHUTTERSTOCK ➤

SHUTTERSTOCK

Rice terraces on the South Korean island of Namhae are primarily cultivated with rototillers.

ATTILA JANDI, SHUTTERSTOCK

Manual cultivation still prevails in North Korea; there is a terraced orchard on the slope in the background.

VALERIJ ŠANIN, SHUTTERSTOCK

Except in Sabah State in northern Borneo, agricultural terraces are uncommon in Malaysia.

PETER KUMER

Sowing rice on the Shan Highland in eastern Myanmar.

◀ The terraces of the Ifugao people with their high slopes, some built of stone, in the middle of the island of Luzon in the northern Philippines were added to the UNESCO World Heritage List in 1995. KLARA VLASAKOVA, SHUTTERSTOCK

Indonesia there are terraces everywhere, but the best-known ones can be found on the Philippine island of Luzon and the Indonesian islands of Bali and Java. There are fewer terraces in Malaysia; the most by far are found in northern Borneo. There is also extensive terracing in hilly areas of Myanmar, Thailand, and Vietnam. Some of these are considered the most attractive terraced landscapes in the world.

Agricultural terraces have multiple significance: economic because the produce from them provides food and material security to the population; cultural because it was in terraced areas in inhospitable and remote mountain areas where traditional languages, customs, cuisine, festivals, dances, songs, literature, and beliefs were preserved (Kezhong 2012; Asian Rice … 1995); aesthetic because they blend in exceptionally well with the natural environment and offer visitors a feeling of peace and comfort (Asada 2009); and environmental because environmentally friendly management makes possible the existence and flourishing of many habitats (Kezhong 2012). Terraced areas perform many other ecological and environmentally protective functions: they retain floodwater, filter water, feed aquifers (Liu et al. 2004), retain fertile soil in steep areas, and prevent its erosion (Sidle et al. 2006; Van der Linden 1983; Midmore, Jansen and Dumsday 1996; Van Dijk and Bruijnzeel 2004).

Farming in terraced landscapes in these parts of Asia is still characterized by collective labor, which has influenced the hierarchy of structures and the state (Earls 2012). Alongside work on the terraces there also developed the division of labor between men and women (Min and Zhiyong 2012).

Terraces are mostly family-owned, and the rights to use them and the rules for working them are inherited or defined by tribal laws. The knowledge of managing terraces is passed down from generation to generation. Terrace management is characterized by cooperation between all members of the community. The role of each individual is clear. It is also important to be aware of and maintain balance between various natural and artificial ecosystems, act in sync with the lunar cycles, safeguard the soil, and use natural pest-control methods (Rice Terraces of the … 1995; Paddy Agriculture 2015).

The basins of irrigated terraces where rice is cultivated retain water for at least three-quarters of the growing period. They are fed by monsoon rains or irrigation canals connected to mountain streams. The floor of the basin is covered with a tamped layer of impermeable soil, and the earthen walls on the edges can hold a layer of water 10 to 15 cm deep (Paddy Agriculture 2015). Rice is planted by hand in the soil below the water, and when it ripens the basins are dry. There can be several harvests per year. The success of farming on irrigated terraces, which are more common than dry ones, depends on an effective irrigation system and water management. Since time immemorial, the people living there have skillfully built complicated irrigation systems. Integrated farming developed, which along with rice cultivation on terraces includes water buffalo, other livestock, ducks, and even fish and eels (Asian Rice … 1995; Cultural Landscape of Honghe … 2013), and the available water can be also a source of drinking water for the residents (Shaowen 2012).

Dry terraces in drier climates are most often used to grow corn, sorghum, wheat, cotton, and potatoes (Min and Zhiyong 2012).

Four types of terraces are known in monsoon Asia. On slightly inclined slopes at lower elevations, terraces are supported by kneaded earth up to half a meter high. On steeper slopes, the lower part of terrace slope is built of stone covered by a layer of soil. The terraces in the steepest parts have exceptional aesthetic value and their construction is the most demanding. There, using the simplest materials to build them, such as kneaded earth, is no longer possible. Thus the terrace slopes are fully made of stone, and in the very steepest areas are slightly inclined. Where there is constantly water in the basins, the slopes are reinforced to withstand its weight (Asian Rice … 1995).

Terraced landscapes are increasingly threatened by improper management because new technology is resulting in farmers losing knowledge of traditional cultivation and maintenance of terraces, abuse of pesticides, which destroy their natural regeneration mechanisms (Settele 2012), clearing of forests at higher elevations, which results in occasional flooding of terraces (Internet 4), and abandonment of terraces due to rural flight (Junchao 2012). The best-known and most often visited terraces in the parts of Asia examined here include the Hani terraces in China's Yunnan province (Zhiqiong 2012; Cultural Landscape of Honghe … 2013), the terraces cultivated by the Ifugao people in the Philippines (Junchao 2012), and the terraces near the town of Sa Pa in Vietnam (Tourism and Rice Terraces 2008).

The Hani terraces were added as a cultural landscape to the UNESCO World Heritage List in 2013. They comprise over 16,000 ha and cascade down the slopes of the Ailao Mountains to the valley of the Red River (*Hóng Hé*). Over the course of 3,500 years, the Hani people developed a complex system of canals for carrying water from the forested peaks of the mountains to the terraces. Their flexible system of managing the rice terraces is an example of harmony between people and the environment based on traditional social and religious values (Cultural Landscape of Honghe … 2013).

The over two-thousand-year-old terraces in the Philippine Cordilleras on Luzon were added to the UNESCO World Heritage List in 1995. They are tended by the indigenous Ifugao people. Although they are threatened by rural flight, an insufficient labor force, abandonment of neighboring terraces, climate change, and the drying up of creeks necessary for irrigation agriculture there, work on them still goes on in line with the long-standing tradition and religious rituals that preserve the balance between nature and man, which was not even disrupted by Christianization in the mid-twentieth century (Rice Terraces of the … 1995).


SOUTHERN ASIA

Agriculture and the terraced landscapes in the Himalayas and the Indian subcontinent are characterized by elevation zones and a monsoon climate. Unique conditions, in which a full 90% of precipitation falls from May to September (Gardner and Gerrard 2003), also make it possible to cultivate rice in southern Asia, and so the terraces there are similar to the better-known terraces of eastern and southeast Asia.

There are terraces in all of the countries of southern Asia, from Pakistan in the west through India and Nepal to Bhutan in the east and Sri Lanka in the south. There are fewer of them in the largely level terrain of Bangladesh.

In the uplands of the Nepalese Himalayas there are two types of terraced land: *khet* and *bari*. The first is characterized by level irrigated terraces where rice is cultivated, and the second by terraces that are not connected to irrigation and for which crop cultivation depends on the precipitation available. They are primarily used to grow corn, millet, wheat, and barley (Gardner and Gerrard 2003; Contessa 2014).

The terraces in the Himalayas are usually connected to two types of settlements. Compact permanent settlements surround intensively cultivated land on old, mature terraces, and scattered settlements, which are more recent and usually connected with transhumance, are associated with terraces in the early stages of development (Andress 1972).

Irrigated terraces lie higher on the slopes, closer to springs or creeks, on flood plains, or on the banks of major rivers. Rice is grown on all of them, whereas other crops grown in rotation depend on their location. On the slopes of the Himalayan uplands other crops can also be grown during the cold part of the year, but not in the valley bottoms because the microclimate is too cold (Andress 1972).

RAM KUMAR, FLICKR

A terraced slope near the town of Kodaikanal in the Western Ghats in southern India.

SHUTTERSTOCK

Carefully cultivated terraces in Ladakh, a mountainous area in extreme northern India.

◄ This slope in the initial phase of terracing on a steep fan is primarily the result of a quickly growing population and continuing predominant subsistence farming in poorly accessible parts of the Indian Himalayas.
SHUTTERSTOCK

YONGYUT KUMSRI, SHUTTERSTOCK

Extensive terraces in Kagbeni on an alluvial fan of Nepal's Kali Gandaki River at an elevation of nearly 3,000 m.

JEAN MARIE HULLOT, FLICKR

The nearly desert-like terraced valley in the rain shadow of the High Himalayas allows only one harvest per year.

SHUTTERSTOCK

On the wet southern slopes of the High Himalayas in Nepal, paddy rice is grown up to an elevation of 2,000 m.

SANDI KELNERIČ

Small, carefully cultivated terraces on steep slopes are mainly used for rice production.

◀ A carefully cultivated terraced landscape on the extensive slopes of the southern foothills of the High Himalayas in Nepal; terrace expansion and cutting firewood are reducing forest coverage. JEVGENIJ GORODECKIJ, SHUTTERSTOCK

VIDU GUNARATNA, SHUTTERSTOCK

Due to their high elevation, terraces in the mountainous heart of Sri Lanka are mainly used for cultivating vegetables.

CLAUDIO VIDRI, SHUTTERSTOCK

Picturesque, irregularly shaped terraces with steep treads in Sri Lanka's mountainous interior.

FLICKR

Vegetable and orchard terraces in Pakistan's Hunza District on the edges of the Karakoram range.

FLICKR

Terraced plots in a village in eastern Bhutan in their fallow period.

Some terraces are not connected to irrigation systems but instead rely on precipitation and are more important for the local economy. In India's western Himalayas there are two versions. The first has level terrace platforms with support walls composed of earthen slopes and sometimes of stone and a few trees, and the second has gently inclined terrace platforms with a slope without stone walls or trees (Andress 1972). With the inclined platforms, the inner side of the platform (below the neighboring slope) has a ditch that channels away surface flows and prevents the occurrence of gullies (Shrestha, Zinck and Van Ranst 2004).

In the Nepalese uplands, rice terraces are cultivated by farmers that own less than half a hectare of land. To make a living, they seek additional employment as hired hands on other farms or as porters. Two or three different crops are rotated per year. The terraces lie at an elevation of 2,000 to 3,000 m, mostly on the middle or lower parts of moderate slopes with relatively thick soil (50 to 80 cm, and up to 120 cm). During the monsoon period they produce rice, followed by potatoes and wheat. The terrace platforms are usually 2 to 6 m wide; it is easier to cultivate wider ones. The width of the platform and the height of the slope depend on the inclination of the terraced slope (Shrestha, Zinck and Van Ranst 2004; Bhattarai 2008).

The slopes of the irrigated terraces are up to 1.5 m tall and they also have rims that rise 20 to 25 cm above the terrace platform, making it possible to flood the paddy until the rice is ripe. The depth of the water is usually between 10 and 15 cm. Temporary openings in the rims allow the water to flow to lower terrace levels. The openings are stuffed with rice straw, which allows only the water to flow through, and not sediments. The terrace slopes have an inclination of 40 to 60° (83.9 to 173.2%). To improve stability, stone is built into them or they are covered with grass. The grass also serves as fodder and green manure because at the end of the monsoon rains the grass from the lower part of the slope is scraped onto the platform below. The farmers also use manure from stables and, to a lesser extent, artificial fertilizers (Bhattarai 2008).

In India and Pakistan, stone irrigated terraces are more common, based on the traditional *khuls* irrigation system, or a system of canals leading from watercourses to cultivated land (Ferrand and Cecunjanin 2014).

Before the farmers plant the terraces they regularly renovate them. Maintenance is very labor-intensive because gullies or landslides are constantly appearing on the land. Some data suggest that a full 80% of slumps occur on rice terraces because of their long-term saturation and simultaneous monsoon rains. Terraces with inclined platforms are most exposed to soil erosion (Shrestha, Zinck and Van Ranst 2004).

Cultivation of the land results in strong social cohesion among the villagers because all members of the community participate in maintaining the terraces and irrigation systems (Raj Khanal and Watanabe 2006). The costs of maintaining the terraces are over €700 per hectare per year, and the costs of building new terraces are up to €8,500 per hectare (Bhattarai 2008). It is most expensive to build level rice terraces, so construction of less level terraces is cheaper (Shrestha, Zinck and Van Ranst 2004).

The annual cultivation cycle at elevations of 1,000 to 2,000 m is usually as follows: potatoes or wheat are grown between January and March; in March stable manure is brought to the terraces, where it is usually spread in April; in June and July the terraces are flooded for growing rice to be harvested in October and until the harvest the terraces are flooded three or four more times; after the harvest, in October or November, manuring is repeated, the grass is again scraped from the slopes between the platforms, and damage caused by slippage is repaired; in November potatoes or wheat is planted and artificial fertilizer may also be applied; during this time, the land is watered several times. Work is usually done by hand, but small tractors may also be used (Bhattarai 2008). At lower elevations there are two rice harvests per year, and may even be three (Shrestha, Zinck and Van Ranst 2004). In Sri Lanka, vegetables are cultivated on rice terraces in rotation with rice. Terraces with tea plantations are also characteristic, and in places tea is being replaced by vegetables (Amarasekara, Dayawansa and De Silva 2014; Watson 2014).

On terraces with inclined platforms, or *bari*, corn is grown from March to June, millet between July and September, and all of these terraces lie fallow or are sown with wheat in winter (Gardner and Gerrard 2003; Shrestha, Zinck and Van Ranst 2004). At elevations over 2,000 m only one crop is produced per year, typically millet or potatoes (Fuyusawa 2001).

In the Nepalese part of the Himalayas, land abandonment is a major problem. In places, half of all *khet* land and nearly two-fifths of *bari* land have been abandoned, and in some places in wider areas more than a third of the land. In addition to the geomorphological processes that terraces are constantly exposed to and that occur on more than two-fifths of abandoned land, the land is also endangered by grazing animals or soil compaction, which changes the surface and subsurface runoff. In places, slippage or flooding has damaged around one-tenth of *khet* land, and on one-third of abandoned land damage to terrace slopes is evident. The abandonment of land also impacts the food supply in poor regions, which already face problems with insufficient food. Due to abandonment, rice production has fallen by nearly half, and corn and millet production by two-fifths. Because traditional labor-intensive farming is not economically attractive, in places – for example, in the Hindu Kush Mountains – there have been attempts at market-oriented fruit production and plantations (Raj Khanal and Watanabe 2006).

Some terraces are only periodically abandoned. During this time they may be damaged by slope processes or overgrowth with brush (Andress 1972). The reasons for abandoning land are the same as elsewhere around the world: commercialization of agricultural production, depopulation, and abandonment of farming. Abandonment has been especially marked since 1980. In the first decade of the twenty-first century, around 1% of available farmland was abandoned every year (Raj Khanal and Watanabe 2006).

SOUTHWEST ASIA

Southwest Asia has a great diversity of landscapes and comprises the Middle East (with Afghanistan and Iran to the east, and Iraq, Syria, Jordan, Lebanon, Israel, and Palestine to the west), the Arabian Peninsula (Saudi Arabia, Kuwait, Qatar, the United Arab Emirates, Oman, and Yemen), the Persian Gulf island country of Bahrain, and the Asia Minor peninsula, mostly represented by Turkey. Also considered part of the region are Transcaucasia (Georgia, Azerbaijan, and Armenia) and the island country of Cyprus, which is part of Asia in terms of physical geography and has a considerable share of terraced land.

Except for central Iraq, where ancient Mesopotamia flourished along the Euphrates and Tigris rivers, the eastern part of the Arabian Peninsula, and small coastal plains, the region has rugged terrain. It has subtropical and temperate climates; the former is divided into arid desert and steppe climates as well as a wetter Mediterranean climate. The ancient terracing of cultivated land is also adapted to the diverse natural conditions with varying quantities of water available for survival and irrigation.

In Israel, the oldest agricultural terraces date back about 4,500 years (Bensinger 2008). They were innovations by the Israelites. Large-scale terracing started in the second half of the first millennium BC, when, along with the ready established cultivation of the plains, people

BOJAN ERHARTIČ

Narrow terraces with high stone slopes in a typical village in the middle of the Yemeni Highlands.

SHUTTERSTOCK

A terraced slope with fruit trees above Faraya in Lebanon's mountainous interior.

◀ The western mountainous part of Yemen in particular has been so distinctly shaped by agricultural terraces that the slogan »Yemen was made by man« began to apply to the entire country. ROBERT BRGLEZ

WOLFGANG ZWANGER, SHUTTERSTOCK

The Arabian Peninsula also features an abundance of terraces in mountainous interior of northern Oman.

SHUTTERSTOCK

An interesting landscape in Jordan with terraces carved into the solid rock.

OREN ACKERMANN

A typical Mediterranean terraced landscape with olive trees in the Judean Mountains south of Jerusalem.

SHUTTERSTOCK

A terraced landscape with partly abandoned terraces in a mountainous village in southern Turkey.

also started cultivating slopes and karst areas with shallow soil. This soil constantly accumulated from the unterraced surroundings on the level terrace platforms supported by stone slopes. Terracing was facilitated by the nearly horizontal orientation of the limestone strata (Akmiran 1987). In the first and second centuries, land was also terraced by the Nabataeans with their capital at Petra (Rice 2006). Archaeological studies supported by dating have confirmed terraces less than two millennia old (Davidovich et al. 2012).

On slopes, water flowed via gravity from terrace to terrace in volumes agreed upon between users. In places, tunnels or channels were carved through the rock to allow the flow of water (Ron 1966). Terraces where olives, figs, almonds, pomegranates, and grapes were grown were not irrigated; they were only watered by seasonal rain. The stone that was not built into the terrace slopes was used to build towers for watching and protecting the crops (Bensinger 2008).

The terraces have been being abandoned since the nineteenth century and the terraced landscapes are deteriorating. Jewish farmers have modified some of the terraces near settlements for modern agriculture (Akmiran 1987).

Terraces are also deteriorating in Palestine. In the West Bank, they cover 57% of the hilly terrain (Hammad and Børresen 2006). The Palestinian terraced cultural landscape in the Battir area south of Jerusalem was added to the UNESCO World Heritage List in 2014 as »Land of Olives and Vines« (Schiel 2013).

On the steep wet slopes of Mount Lebanon range, farming is based on hillside terraces. Some of them are over 2,500 years old; when the Phoenicians also started felling the forests in the mountainous interior, they terraced the new cultivated land. In the Mount Lebanon, there is 950 km^2 of terraced land, which has largely been abandoned because of the long-running civil war (Zurayk 2008).

The terraces on the mountain slopes of Yemen are a delight to see. The farmers arranged them before the reign of the legendary Queen of Sheba and grew barley, wheat, and sorghum on them (Rivera 2012). The land acquired the name *Arabia Felix* »Fertile Arabia« and the Arabs call it »Green Yemen« because of the diversity of crops there. Most of the land is not irrigated, and so farmers have to adapt to the spring and summer rainy seasons (Varisco 1983).

The average mountain farm measures only 1.4 ha and has several terraces (Aw-Hassan et al. 2002). In the highlands of Yemen there are stone terrace slopes, and in Hadhramaut in the eastern part of the country they are built of loam (Almeshreki et al. 2012).

Traditional farming on terraces does not follow modern trends. Millet is being replaced by corn, and coffee, which is important as an export goods, is being replaced by the narcotic khat (Varisco 1983; Erhartič 2009a).

For the development of agriculture in Yemen, it is important to prevent the further deterioration of terraces and increasing erosion. Because of erosion, the water reservoirs intended for irrigating more competitive arable land on the plains are quickly being filled by sediment, as a result of which increasingly less water is available. Because of the faster water runoff, flash floods are more frequent in the valleys. In Yemen there is an established belief that the terraced landscape is an exceptional cultural asset that must be preserved for posterity, and that terraces that are already abandoned must be brought back into use (Varisco 1991). International programs for promoting the development of agriculture recommend the introduction of greenhouses with less wasteful drip irrigation (Aw-Hassan, Bruggeman and Yassin Ebrahim 2002).

The dramatic terraced landscape of Oman is characteristic of the higher elevations of the Jebel Akhdar range. The irrigation canals known as *aflaj*, carved into the cliffs, are masterpieces of engineering. Water flows from springs to each house, and then from there to the terraced fields, which is why the settlements stand above terraced land (Al Jabal …). The *aflaj* area, which was added to the UNESCO World Heritage List in 2006, includes five of about three thousand *aflaj* systems that are still active in Oman. They were introduced during extreme drought conditions approximately 4,500 years ago and were inspected and defended by round stone watchtowers (Aflaj … 2006).

Terraces are also found in mountainous southwestern Saudi Arabia. On the steep slopes in the Asir region they are narrow, especially on the slopes facing the Red Sea. Openings in the stone embankments allow water to flow by force of gravity from terrace to terrace. Terrace farming with a centuries-old tradition has regressed in past three or four decades because of a lack of maintenance of terraces resulting from the population moving to lower-elevation areas and an increase in intensive farming with irrigation in flat areas where there are extensive groundwater reserves deep below the surface (Al-Turbak 1999).

In Turkey only the center of the country, which is dominated by plateaus, does not have terraces. In western and southwest Asia Minor, terraces were arranged even by the ancient Greeks, but they were abandoned because of the population moving to cities and emigrating. More of them remained in the rural east of the country, in the valleys that open to the south toward Kurdistan.

There is little information about the terraces in Transcaucasia. We found only one report from Armenia, according to which irrigated terraces were set up in order to increase arable land (Armenia 2013).

There are more terraces in Iran, although these are fewer than one would expect given the size of the country and its arid climate, large population, and rich agricultural tradition. The largest number of terraces are in the Zagros and Alborz mountains, where irrigated terraces are used to produce various legumes, vegetables, and rice (Bowen-Jones 1968), which is still a staple in Iranians' diets. Rice paddies are especially common above the Caspian Sea.

Agricultural terraces are also rare in Afghanistan, with the notable exception of the province of Nuristan in the Hindu Kush Mountains in the extreme northeast part of the country. Nuristan experiences summer monsoon rains, and so it is covered with trees cover unlike the rest of Afghanistan. The small terraces have stone slopes and are separated by earthen embankments. Water is brought to them from rivers and mountain streams via a complicated system of open canals and aqueducts built from hollow logs (Edelberg and Jones 1979). Unfortunately, Nuristan also became a flashpoint for attacks during the country's civil war. The terraces there, with their slopes 1 to 1.5 m high, were very clearly included in the description of the battle at Wanat in July 2008, when Taliban guerrillas attacked US and Afghan soldiers (Wanat … 2008). There are also some terraces in the province of Farah in the western part of the country.


AFRICA

GWENDOLYN STANSBURY, FLICKR

Agricultural terraces in Ruanda with low slopes and steep platforms are common across all of central Africa.

GWENDOLYN STANSBURY, FLICKR

Rwanda is a treasure trove of terraces, which are also created to prevent soil erosion.

FLICKR

In Rwanda, tea plantations often alternate with terraces where food is grown for household consumption.

FLICKR

Even though terraced land in Rwanda is cultivated almost exclusively manually, every inch is carefully cultivated.

◄ Terracing slopes as part of public works in Rwanda, a country with a rapidly growing population in the mountainous heart of Africa with most likely the largest share of terraced land on the dark continent. SAM THOMPSON, FLICKR

DRAGO KLADNIK

In some places, the terraced vineyards in Stellenbosch alternate with terraced orchards, where olive tree cultivation is beginning.

DRAGO KLADNIK

South Africa's dry interior is characterized by indistinct terraces, which are the result of cultivation that followed the contour lines of the gentle slopes.

SHUTTERSTOCK

South African grassland terraces lack proper slopes; their platforms are separated only by unplowed and unmown low ridges.

FLICKR

These types of low ridges between the platforms that are used for retaining soil moisture can also be found on the gentle terraced slopes of Lesotho.

◄ South Africa is also quite densely crisscrossed with agricultural terraces, which, however, are not very distinct; some, like the terraced vineyards in Stellenbosch, complement the already attractive landscape. DRAGO KLADNIK

SEBASTIEN BUREL, SHUTTERSTOCK

Due to Asian influence, irrigated rice terraces predominate in Madagascar.

FLICKR

Recently terraced slopes in Tanzania are used for producing higher quantities of food and fighting soil erosion.

FLICKR

Terraced land in the highlands of western Kenya are used mainly for subsistence farming.

DMITRIJ PIČUGIN, SHUTTERSTOCK

On the shores of Lake Bunyonyi in Uganda, terraces literally »grow« from the water.

MATJAŽ GERŠIČ

Terraced fields in the Ethiopian Highlands near the Simien National Park in northern Ethiopia lie fallow during the dry winters.

MATJAŽ GERŠIČ

Higher elevations in the Ethiopian Highlands are greener, but even the terraced fields there only allow one harvest per year.

MATJAŽ GERŠIČ

The terraced landscape in southwestern Ethiopia, which is cultivated by the Konso people, is on the UNESCO World Heritage List.

MATJAŽ GERŠIČ

Extensively cultivated terraced fields and pastures in the area inhabited by the Dorze people in southwestern Ethiopia.

NICRAM SABOD, SHUTTERSTOCK

The most terraced country in North Africa is Morocco, where terraces are especially common in the High Atlas Mountains.

SHUTTERSTOCK

It is only in summer that the care with which every inch of the terraced land in the High Atlas Mountains is cultivated becomes visible.

MATJAŽ GERŠIČ

Terraces with apple trees on a steep slope near the Toubkal National Park in the High Atlas Mountains.

DENNIS JARVIS, FLICKR

An unusual terraced landscape in Tunisia with stone walls used for preventing erosion and retaining moisture in the thin soil.

With a fifth of the Earth's surface and only a tenth of the world population, Africa is a continent of vast expanses. Many parts are unsuitable for habitation and are thus sparsely populated, with the highest population density in coastal, river, and lake areas (Bennett Lee 2003). Agriculture, which was only of little importance during its very early beginnings ten thousand years ago, gradually developed the cultural landscape (Luhr 2006). Within the palette of diverse agricultural land, terraces are especially interesting. In Africa they can be found in all regions, but they differ from one another depending on the different natural environments and formation periods.
The oldest depiction of agriculture terraces, from around 1400 BC, can be found in Deir el-Bahari temple in Egypt. There are depictions of terraces in the Land of Punt, which is believed to have encompassed part of northern Somalia. They have already been overgrown by trees, the resin of which is used in incense and essential oil production (Zayed Hamid and Devisse 1981). Agriculture on terraced land was also

JOHN COPLAND, SHUTTERSTOCK

One of the most terraced areas on Earth is Macaronesia, which is composed of the Azores, Madeira, the Canary Islands, and Cape Verde; in Cape Verde, terraces predominate on the mountainous island of Santo Antão.

JORG HACKEMANN, SHUTTERSTOCK

One of the most unusual terraced landscapes can be found on Lanzarote, where semicircular stone walls were built on dark volcanic soil to protect individual vines.

PAWEL KAZMIERCZAK, SHUTTERSTOCK

Banana terraces with tall stone walls on a steep slope on La Gomera, Canary Islands.

DRAGO KLADNIK

Terraces with grassed-over earthen slopes in the wet north of the largest Canary island of Tenerife.

SHUTTERSTOCK

Large leveled terrace platforms adapted for mechanical cultivation on Gran Canaria in the Canary Islands.

JORG HACKEMANN, SHUTTERSTOCK

In addition to terraced vineyards, the island of Lanzarote also has terraces where early vegetables are grown.

established in the Kingdom of Aksum (fourth century BC to first century AD) in the north of present-day Ethiopia, where the people still farm in a similar manner. The terraces were irrigated with water from the Ethiopian Highlands, plowed with yoked oxen (Michalovski 1981), sown with wheat and other grains, and planted with grapevines.

Ancient civilizations in the western parts of Africa were also familiar with terrace agriculture. The Neolithic Guinea culture in the territory between present-day Senegal and Nigeria built terraces on steep slopes and cultivated them with stone tools. A good example of such terraces is at Rim southwest of Aribinda in Burkina Faso. Despite the sparseness of the terraces, the use of new tools, fertilization with manure, hoeing, weeding, and controlled irrigation have significantly contributed to the development of agriculture (Andah 1981). Remnants of agricultural terraces from the Almoravid period are visible in Mauritania (Bathily and Meillassoux 1988). The cultivation of terraces continued to be practiced along the Gulf of Guinea even afterwards as well, especially intensively by the Adangme peoples, who used them for sorghum cultivation (Andah and Anquandah 1988).

The terraces in southern Africa are seven centuries old, especially the ones south of Zambezi River. They are characterized by terrace slopes built from stone (Phillipson 1981). Even then, the numerous terraces in Madagascar were particularly prominent. They were built under the influence of Asian civilizations and are therefore similar to the terraces in southeastern and southern Asia (Vérin 1981).

Agriculture on terraced land was maintained until the arrival of colonialists. After the Portuguese and other Europeans arrived in what are now Zimbabwe, Mozambique, Zambia, and Malawi, they encountered not only several mines, but also a developed and prosperous terraced agriculture, especially in the Nyanga area in Eastern Highland of Zimbabwe, where the locals arranged terraces on steep slopes with embankments strengthened with dry stone walls about 1 m high (Niane 1984). They only irrigated them during the dry season because there was generally sufficient rainfall (Bhila 1992).

However, terraced land was not only used for agriculture. Mapela Hill in the Limpopo River Valley is a good example of a populated terraces. Their slopes were built from stone and they were used for gardening and defense, and some oh them apparently reflected the social status of the local inhabitants (Fagan 1984).

The scouts that inspected individual territories before the arrival of the colonial armies and colonial administration reported prominent terraced land. Two such reports describe terraces in Nigeria. The slopes there were completely covered by terraces, with the terrace slopes made of stone up to 1 m high, and with platforms in some areas just wide enough to be sown with a single row of durra. These terraces were called *pang* or *pang'gang*. Special tools were developed to create and maintain them (Gwimbe 2008a, 2008b).

Because the literature about Africa in the nineteenth and twentieth centuries does not explicitly mention agricultural terraces, they were probably never recognized as an integral part of the landscape. Much more attention is given to them now. On many slopes people are making new terraces.

Rose (2008) mentions two main areas that feature agricultural terraces. The first encompasses the northern and the northwestern part of Africa, where the slopes were terraced under the influence of Muslim slave traders. This area is characterized by poor, shallow soil and a sparse population. The area includes the Dogon Plateau in Mali, southeast Nigeria, Mafa tribal territory in Cameroon, the Rif and Atlas mountains in Morocco, regions in the mountain ranges of Algeria and Tunisia, and the territory on the border between Togo and Benin (Rose 2008; Internet 1). The second area features high-quality soils and higher population density. It includes Rwanda, Burundi, Kenya, Tanzania, Ethiopia, Comoros, and Madagascar (Rose 2008).

Rose (2008) divided the terraces in both areas into three types. The first type are step terraces, where the terrace platforms are flat and the slopes are made of stone walls or earthen embankments, which are grown over with grass or bushes. The second type are terraces with inclined platforms and slopes made of stone, hedges, or grassed-over earthen embankments. The third type are slope terraces, in which the terrace platforms preserve the slope's original inclination with trenches and embankments on both sides in order to prevent excessive soil erosion.

Examples of traditional terraces can be found in South Africa as well; however, they are scant. In the territory of the Venda people, in the province of Limpopo, terraced land is characterized by dry stone slopes called *mitsheo*. Proficiency in masonry was vital for their assembly. Under Apartheid, this territory was settled by blacks and agriculture started to regress. The terraces were an exception because terrace construction and maintenance is an important tradition for the locals, which helps them contribute to the preservation of their cultural heritage (Critchley and Brommer 2003). In South Africa, it is also necessary to point out the territory surrounding the village of Emgwenya, where there are still visible remnants of agricultural terraces over 50 km long and over five thousand years old (Hromnik, Wade and Heine 2008).

Whereas some areas were characterized by precolonial agricultural terraces, there are numerous examples where the farmers were encouraged by the colonialists to use their style of terrace arrangement to prevent soil erosion. A typical example is the mountainous Kabale District in southwestern Uganda, where in 1940 the colonial authorities demanded that the farmers plant elephant grass (*Pennisetum purpureum*) on the slopes at intervals of approximately 15 m. This formed inclined terraces with deep, fertile soil. The soil is held back by the obstacle created by the grass. The difference in the soil quality of an individual terrace platform is also noticeable in the yield. The highest and most quality is directly behind the grass barrier and its quantity declines in proportion to the platform width (Critchley and Brommer 2003).

In East Africa, the significance of terraces is reflected in the fact that in Swahili the word for them is *fanya-juu*, meaning »do up«. The terraces are constructed by first digging a ditch 60 cm deep and wide, and then throwing the material above the ditch, and in this way forming the slope, which is later grassed. The slightly inclined terrace platforms are 5 to 20 m wide. Since the mid-1980s, the people in the Machakos region in Kenya have constructed many terraces, so that now approximately 70% of cultivated land is terraced. Yields have increased by up to 150%. Terracing is suitable for slopes with inclinations between 5 and 50%, where the soil is deep enough, and with an annual rainfall of at least 700 mm (Thornton 1999).

SOUTH AMERICA

JAKA ORTAR

Restored terraces in Machu Picchu with slopes of the same height built from stones and rocks of various size.

DRAGO KLADNIK

The unusual circular terraces at Moray near Cuzco were probably an Inca agricultural experiment station.

DRAGO KLADNIK

Inca terraces are abandoned in many places in Peru, which, however, is not the case in the Sondondo Valley in the Andamarca District.

DRAGO KLADNIK

One of the most distinctly terraced areas in Peru can be found in the Colca Valley, which turns into a deep canyon downstream.

◄ The magnificent terraces of the lost city of Machu Picchu in Peru built by the Inca around 1450. The Inca lived there for only a century until abandoning it after the Spanish conquest, and so the city remained forgotten until its rediscovery in the early twentieth century. SHUTTERSTOCK

Like pyramids, terraces also developed independently across the globe. Although there have been relations between Europe and Asia for millennia, which could also indicate the transfer of various agricultural practices, this cannot be said for transatlantic relations. This means that the same needs among different peoples demanded a related form of cultural landscape development.

The terraces in South America are often associated with the western part of the continent, the Andes, and especially with the central, Peruvian part of the mountain range, the cradle of the Incan terraces. This correlates with the aesthetic of the Incan terraced landscape, which is marketed all over the world as a tourist attraction in connection with what is probably the best-known South American archeological site, Machu Picchu, which is included on the UNESCO World Heritage List. The Incan terraces are just a small part of the Andean terraces (Goodman Elgar 2002), which in the Spanish part of Latin America are called *andenes*; it is unclear whether this term is related to the Andes Mountains (Denevan 2001; Goodman Elgar 2012). In South America, terraces can also be found in Brazil and Venezuela, and all across South America where there is intensive cultivation on slopes (Williams 1990; Casão Junior, Guilherme de Araújo and Fuentes Llanillo 2012). It is true, however, that the diverse landscape of the Andes makes it necessary to adapt agriculture to the natural conditions and the terraces are therefore more widespread there than in the less rugged, eastern flat areas of the continent. In the Andes, they are found as high as 4,500 m and are a characteristic part of its cultural landscape. Most can be found in southern Peru, Bolivia, and northern Chile, and fewer in Ecuador and Colombia.

The oldest terraces go back to the fourth millennium BC (Denevan 1988; Earls 2012; Kendall 2012). Most Andean terraces date from the pre-Columbian era. They were mentioned by several Spanish chroniclers at the beginning of the seventeenth century because they made such an impression (Goodman Elgar 2002). Like in the European Mediterranean regions, the construction and spread of terraces were periodic here as well (Guillet 1987).

Several types of terraces developed, depending on the natural conditions and needs. In valleys, the terrace slopes are mostly earthen, whereas stone embankments predominate on slopes. Among the latter, wide platforms are less common, often with irregular shapes, divided by a low wall and sometimes surrounded by dry stone walls. More prominent are narrower terraces that are adapted to the terrain and follow the contours. These are curving terraces. They are usually bordered on both sides with flanking walls. Probably the most distinct ones are the linear terraces (e.g., the Incan terraces), which were used to geometrize the embankment and create a »regular« linear step-like formation. It is specifically these that became known as *andenes* (Goodman Elgar 2002).

Terraces may be short or long. The first ones are created by building stone barriers in gullies to prevent gully erosion and at the same time trap soil. The long terraces can be divided into completed terraces and gradually formed terraces. The first ones are built with a retaining wall with a completely formed cultivation area; these include the Incan terraces.

ISRAEL HERVAS BENGOCHEA, SHUTTERSTOCK

The terraced landscape in northern Chile with the town of Putre on a high plateau under the volcano Taapaca.

MARISA ESTVILL, SHUTTERSTOCK

A landscape with scattered farms and indistinct terraced land near Zumbahua in central Ecuador.

The second ones are merely accompanied by a simple wall (hedges could also be used) and the cultivated land behind it is shaped through erosion, which carries soil down from higher ground. The terrace is finally completed when the entire area behind the wall is filled in (Immerzeel and Oosterbaan 1989; Valdivia 2002).

Based on their form, the Andean terraces can be divided into monumental and vernacular terraces. The first ones are characterized by a planned configuration, uniform shape, precisely worked stones for walls, and irrigation systems, which are seen in connection with the Wari culture from the second half of the first millennium, and later with the Incas, when a strong centralized authority and class segregation was established. The vernacular terraces that predominate in the Andes are characterized by walls made from unworked stones of various shapes found in situ. The first type of terrace requires much greater effort with regard to the planning and specialization of the builders. The terraces do not occur individually, but in the form of terrace systems (Goodman Elgar 2002; Earls 2012).

The terrace walls generally were not vertical, but slanted toward the slope, and the cultivation area was also never completely level, which prevented excessive water retention (Goodman Elgar 2002).

Because of the arid climate conditions in the western part of the Andes, the terraces were usually connected by irrigation systems. Traditional cultivation included corn, barley, and quinoa. The most appropriate cultivation time was during the rainy season, which lasts from November to March (Guillet 1987).

FLICKR

The slopes on the Bolivian side of Lake Titicaca, the highest navigable lake in the world, are also terraced.

Terraces have a significant effect on the productivity of agriculture. In the Bolivian Andes, terraces increased the yield from 60% (e.g., for onions) up to 260% (e.g., for potatoes). In Peru, the potato yield increased by more than 140%, barley by around 40%, and quinoa by 35% (Valdivia 2002).

Many pre-Columbian terraces were abandoned due to major depopulation after the Spanish colonization. With the arrival of the Spaniards, there was a drastic decrease in the population, mostly due to European diseases and wars. Spain's need for more miners also contributed to depopulation and the abandonment of land use. In Peru alone, half a million out of the estimated one million total hectares of terraced land is believed to have been abandoned. In the Colca Canyon area of southern Peru, the population decreased to nearly one-tenth in the sixteenth century, and today it has grown to only half of its former level (Goodman Elgar 2002; Kendall 2012). With the arrival of the Spaniards, semi-circular terraces were created surrounding individual trees in olive groves (Zaro 2014).

In the 1960s it was reported that in northern Chile 80% of terraces had been abandoned, and in the Peruvian Colca Canyon more than 60% in the late 1980s. Most terraces above 3,600 m have been abandoned (Guillet 1987). Today, only approximately 30% of the terraces in Peru are being cultivated (Kendall 2012), and more than half of the terraces have been abandoned in the greater part of the Andes (Denevan 1988).

In addition to permanently abandoned terraces, there are examples of periodically abandoned terraces, which are related to cycles of older and younger generations in households and a lack of irrigation system maintenance. El Niño is an important factor, which can cause prolonged periods of drought (Guillet 1987; Zaro 2014). Strong earthquakes must also be taken into consideration because they can destroy the terraces and cause major changes in weather conditions at higher elevations, which in turn has an effect on the start of the farming season (Guillet 1987; Kendall 2012).

The contemporary abandonment of terrace cultivation is related to people relocating to cities. Furthermore, the terraces were built with manual cultivation in mind and are therefore less suitable for mechanized agriculture. Their use is limited by private ownership and the related decline of collective work, and by the disappearance of local expertise related to the construction and maintenance of terraces and irrigation canals. Mention must also be made of soil exhaustion, caused by disproportionate use of smaller plots and weather changes, which in the Andes entails more arid conditions, and this in turn has a negative effect on the cultivation of more profitable albeit less drought-resistant crops (Goodman Elgar 2002). In addition, animal husbandry is more profitable than agriculture (Rodriguez and Nockalls 2002).

This is why these countries are trying to promote sustainable use of terraces through various government measures and programs by various organizations (Posthumus and de Graaff 2005), especially to ensure food security in the face of global climate change and tourism development. There is no need for the construction of additional terraces because more than enough abandoned ones are available (Kendall 2012).

CENTRAL AND NORTH AMERICA

Central and especially North America are, together with Oceania and Australia, the least distinctly terraced parts of the word, but some interesting terraced landscapes can nonetheless be found there. There are more of them in Central America, which is made up of the countries between Colombia to the south and Mexico to the north (Panama, Costa Rica, Nicaragua, Honduras, El Salvador, Guatemala, Belize) and the Caribbean, a vast area with numerous island countries, which is divided into the Greater and Lesser Antilles and the Bahamas. In North America, agricultural terraces are exclusive to Mexico and the United States – which Hawaii, in the Pacific, is also part of, but is otherwise geographically part of Oceania.

BRIAN FISK, FLICKR

In the past, the terraced gardens on the Hawaiian island of Kauai were used for growing taro.

FLICKR

The abandoned terraces in the mountainous interior of Oaxaca in southern Mexico are now used for pasture.

The most recognizable terraced landscapes in the United States are located in California, on the outskirts of the western seaboard. The local modern terraces are connected to intensive wine-growing and fruit cultivation. The Santa Ynez Valley northwest of Los Angeles especially stands out. Due to its favorable sunny exposure and Mediterranean climate, people have mainly used it to grow grapes and apples since the eighteenth century. The slopes are covered with many terraced vineyards and orchards, but there are still substantially more traditional unterraced plantations in the valley. The situation is similar for the wine-growing regions of the Sonoma Valley and the Napa Valley north of San Francisco Bay.

An unusual – and also modern – terraced landscape lies in the Central Lowland, especially in the states of Missouri, Minnesota, and Iowa (Internet 6; Internet 7). The terraces there started being created in the 1930s and 1940s (Schottman and White 1993) in order to retain water in the soil, prevent erosion and nutrient leaching, and, last but not least, level the land for intensive farming. A ditch overgrown with grass or an underground pipe, which drains excess water without leaching the soil, often runs parallel to the terraces and the slope (Internet 8). As is general practice in the United States, these extremely vast terrace platforms with low slopes, which beautifully wind across the landscape by adjusting to the surface shape, are used to cultivate mainly soy and corn. The terrace slopes are always made out of earth. Based on the width and the gradient of the terrace platforms, there are three terrace types. The first are wide agricultural terraces with up to a 6% gradient, the second are terraces with platforms up to 15% gradient and grass-covered embankments, and the third are narrow terraces with distinctly slanted platforms that are almost completely overgrown with grass. Due to the narrow terrace slopes only small portions of the terraces is dedicated to cultivation.

The terraces in Mexico have a longer history. Between 1150 and 1521, the Aztecs created new land for farming because of their growing cities and increasing need for food. The terraces in the highlands of central Mexico were mainly built for intensification of farming and to ensure larger quantities of food (Smith and Price 1994; Evans 1990). The terrace slopes were made with stone, trees, or soil (Coe and Koontz 2013). The terraces there were managed by family farms that were independent of the state apparatus (Perez Rodriguez 2006). Nowadays, the terraces in Mexico City are especially interesting; they are used by the poorer residents of the slums for cultivating food on the limited steeper areas (Losada et al. 2011).

Even before the Aztecs, the Mayan civilization is believed to have created agricultural terraces in the Belize area between AD 250 and 900 (Healy et al. 1983; Chase et al. 2011). Today agricultural terraces are also common in rural mountainous areas of Central America, and the same is true in the Caribbean, such as the islands of Hispaniola (where Haiti and the Dominican Republic are located) and Puerto Rico.

◀ A single-row terraced vineyard in the winegrowing Sonoma Valley in California. RON KACMARCIK, SHUTTERSTOCK

OCEANIA AND AUSTRALIA

Oceania is one of the most breathtaking areas on Earth (Kuhlken 2002). The original inhabitants – the Polynesians, Melanesians, and Micronesians – adapted to diverse natural and also social conditions. In addition to farming, their self-sufficient economy was also based on fishing, foraging, and modest livestock farming. It was believed for a long time that terrace agriculture spread across the Pacific from southern China, but then the opinion prevailed that it developed autonomously, without any significant outside influences. The original cultivation based on relocation was replaced by semi-permanent agriculture with fertilization because of the growing population and soil depletion (Morrison, Geraghty and Crowl 1994).

DRAGO KLADNIK

Terraces on Babeldaob, the largest island in Palau, are the result of Japanese mining before the Second World War.

KYLE TAYLOR, FLICKR

In vast Australia, agricultural terraces are extremely rare and indistinct; they can only be found in vineyards and orchards.

This led to the introduction of taro (*Colocasia esculenta*) and yams (*Dioscorea* spp.). The intensification of their cultivation was tied to the flooded fields of wetland areas and irrigated terraces along watercourses and on slopes. These forms of terraces have been studied most in Fiji. Slope terraces are most common on the northern part of the island of Viti Levu, where the largest terraced area measures an astonishing 325 ha (Kuhlken 1994). The terraces there are about four hundred years old. Even though the majority of Fiji's terraces are abandoned, they are still the cornerstone of the cultural landscape. Only some smaller terraces along watercourses on Gau Island and Kadavu Island are still used for cultivating taro (Kuhlken and Crosby 1999).

There are also reports of agricultural terraces from numerous other islands in Polynesia and Melanesia (Kirch and Lepofsky 1993). They have been found on New Georgia, Kolombangara, and Guadalcanal, which are part of the Solomon Islands, on several islands of Vanuatu, on a large scale on New Caledonia, Futuna (the terraces near the village of Tavai date back to the ninth or tenth century), Rarotonga and Mangaia, last two are part of the Cook Islands, on the Tubuai Islands, as well as on the Society Islands of Tahiti, Moorea, and Raiatea in French Polynesia, on Chilean Easter Island, and in the Hawaiian Islands, where they were especially common on Molokai, Oahu, and Kauai (where in early thirteenth century were created).

The exploration of their spread, dating, and comparative language analysis confirms that innovations, including the cultivation of taro using irrigation, arose separately in a number of different locations across Polynesia and Melanesia, but that the innovations are based on previous shared agricultural knowledge. For instance, the ridge terraces on Fiji look like the ones on New Caledonia, the Fiji terraces on level landscapes look like the terraces in the central and eastern part of Polynesia, and the step-like terraces cut into the slopes there look like the terraces on the Hawaiian island of Kauai.

In New Guinea, the bulk of the terraces are located in the mountainous inner part of the island. They are used to prevent soil erosion and retain nutrients in the soil. The main crop on non-irrigated terraces is sweet potatoes, whereas the main crop on the terraces of Vanuatu is taro, which needs to be irrigated, but the terraces are also used to grow kava-kava (*Piper methysticum*), the root of which is used to make a drink with sedative effects (Morrison, Geraghty and Crowl 1994).

Australia is a story in and of itself. There are virtually no records on terraces; apart from a few photographs of indistinct orchard and vineyard terraces, even photographic evidence is non-existent. This shows that agricultural terraces are a rare phenomenon on the smallest continent. The records about them are old. For instance, the author of a book on wine in Australia Kelly recommended terracing for creating vineyards on steeper slopes already in the mid-nineteenth century, but he was aware that hardly anyone would decide to carry this out due to the high expense and because of the vast amount of level land available (Kelly 1862). Hamilton, Hamilton, and Chambers (1943) stated during the Second World War that wheat fields were terraced in Australia shortly before that time.

◀ New Guinea's mountainous interior features a unique terraced landscape characterized by steep terraced slopes and markedly inclined platforms separated by stone slopes primarily intended for preventing soil erosion. OKSANA BJELIKOVA, SHUTTERSTOCK

EUROPE


Legend
Terraced areas
Terraced areas included in the UNESCO World Heritage List
0 100 200 300 400 km
Made with Natural Earth
© 2017, ZRC SAZU Anton Melik Geographical Institute
UPPER MIDDLE RHINE VALLEY (Germany)
WACHAU CULTURAL LANDSCAPE (Austria)
TOKAJ WINE REGION HISTORIC CULTURAL LANDSCAPE (Hungary)
LAVAUX, VINEYARD TERRACES (Switzerland)
JURISDICTION OF SAINT-EMILION (France)
PORTOVENERE, CINQUE TERRE, AND THE ISLANDS (PALMARIA, TINO AND TINETTO) (Italy)
ALTO DOURO WINE REGION (Portugal)
NATURAL AND CULTURO-HISTORICAL REGION OF KOTOR (Montenegro)
CULTURAL LANDSCAPE OF THE SERRA DE TRAMUNTANA (Spain)
COSTIERA AMALFIANA (Italy)

Agricultural terraces are especially characteristic of southern Europe since the Mediterranean is one of the ancient cradles of civilization. When the first settlements arose nine thousand years ago, permanent farming was established in the Fertile Crescent area spreading from the eastern Mediterranean to Mesopotamia. New agricultural innovations appeared and slowly spread towards the west. Even in pre-antiquity, people adapted to difficult natural conditions in the hinterland of Mediterranean Sea and started building terraces, which became common throughout the region as the settled area expanded and the population grew. They already covered a considerable area in ancient Greece (Price and Nixon 2005) and the Roman Empire.

The terraces expanded from the Mediterranean coast into the interior; initially to the southern Alpine foothills, where the benefits of the Mediterranean climate can be felt along the rivers that flow into the Adriatic Sea, the Ligurian Sea, and the Gulf of Lion. With the colonization of higher elevations, agricultural terraces even appeared in the mountainous interior of the Alpine region and also in other ranges of mountains and hills in central and eastern Europe. They are even found in southern parts of Great Britain, where they were built by the Celtic Britons, who probably followed the example of the ancient Romans. Wine-drinking culture, which also has roots in Antiquity, was an important factor in the terracing areas north of the Alps. Although the wine-growing slopes along the Rhine and some of its tributaries have been terraced for more than a thousand years, the extensive wine-growing terraces on the rolling hills around the edges of the Pannonian Basin were built only a few decades ago.

◀ Areas of terraced landscapes in Europe.

The European Union included terraced landscapes in its rural development program for 2007 to 2013. This is an action plan focused on preserving biodiversity by preventing its loss through agricultural activities and a thematic strategy for soil preservation (Lasanta et al. 2013).

MARISA ESTVILL, SHUTTERSTOCK

Terraced olive tree plantations in Extremadura in western Spain.

KOSALA BANDARA, FLICKR

Terraced vineyards in western Switzerland, above the sunward northern shore of Lake Geneva.


THE MEDITERRANEAN

ALJAŽ CELARC

Like Spain's Canary Islands, the Portuguese island of Madeira in the Atlantic Ocean is also distinctly terraced.

SHUTTERSTOCK

Afforested newly terraced land with high slopes in Portugal's southern Algarve region.

SHUTTERSTOCK

Multi-row plantations of grapevines on large terrace platforms with stone walls in Portugal's Douro Valley.

DRAGO KLADNIK

The terraces along the Douro River are dominated by vineyards.

◄ The terraced vineyards on both sides of the Douro River in northern Portugal create one of the most distinctive terraced landscapes in Europe; the terraces appear only in the warmer interior of the valley, away from the relatively cold Atlantic Ocean. DRAGO KLADNIK

DRAGO KLADNIK

In the vineyards of Galicia, retaining walls on narrow terrace plastforms were built with stones grubbed out while clearing land.

SHUTTERSTOCK

An old olive grove on a gently inclined slope with wide terrace platforms and stone slopes in the Southern part of Spain.

SHUTTERSTOCK

Terraces with earthen slopes and planted with blossoming fruit trees spread across the Las Hurdes region in western Spain.

MATTHEW DIXON, SHUTTERSTOCK

The Balearic Islands are also terraced, especially the largest island, Majorca, with diverse cultivars on its terraces.

◄ The enigmatic autumnal atmosphere of the densely terraced winegrowing landscape in the Sil Valley in Galicia, northwest Spain. DRAGO KLADNIK

SHUTTERSTOCK

A landscape with vineyard terraces with stone slopes in the Aosta Valley in northwest Italy

ROSTISLAV GLINSKIJ, SHUTTERSTOCK

Indistinct terraced single-row vineyards in the Piedmont region of northwest Italy.

JAKA ORTAR

A terraced orchard in Tuscany, which is not particularly heavily terraced among Italy's regions.

SHUTTERSTOCK

The steep Amalfi coast in Campania in southern Italy is a true labyrinth of small terraces interspersed with houses.

◄ Italy's terraced Cinque Terre region is a steep coastal belt above the Ligurian Sea, which extends between the towns of Levanto and Porto Venere as a national park crisscrossed by terraced vineyards. It was added to the UNESCO World Heritage List in 1997. JERNEJA FRIDL

DRAGO KLADNIK

Croatia's Zagorje region has exactly the same terraced vineyard landscape as in Slovenia's Pannonian hills.

GORAN ANDLAR

An interesting terraced landscape in eastern Istria, with circular terraces and dry walls that follow the contours of sinkholes.

GORAN ANDLAR

So much stone was grubbed out while terracing the slope above the Bay of Bakar that the high dry walls are as wide as the cleared land.

GORAN ANDLAR

This unusual »terraced« vineyard near Trogir is testimony to the exceptional effort of past generations in cultivating the stony karst land.

◄ The mostly abandoned vineyard terraces above Defora Bay on the south side of the Croatian island of Korčula were created when large quantities of stone were grubbed out to clear land for planting grapevines and built into thick, densely laid out dry walls. GORAN ANDLAR

Archaeological evidence of terraced landscapes in the European part of the Mediterranean is over several thousand years old and can be traced back to the Bronze Age (du Guerny and Hsu 2010; Bevan and Conolly 2011), perhaps even to the Neolithic (Agnoletti et al. 2015; Tarolli, Preti and Romano 2014). The terraces in Malta, as well as the temple that is believed to have stood on a terrace (Rolé 2007), are linked to the ancient megalithic culture from the fifth millennium BC. Agricultural terraces in ancient Greece first appeared in the Minoan civilization (on Crete) and the Mycenaean civilization in the third or second millennium BC (Contessa 2014). They are even mentioned in Homer's Odyssey, written in the eighth century BC (Price and Nixon 2005). The terraces of the Middle Ages are better documented (Agnoletti et al. 2015).

Mediterranean landscapes are heavily marked by terraces because they are one of the main manmade features (Contessa 2014). Understanding terraces »is the key to understanding the chronology and development of many Mediterranean landscapes« (Grove and Rackham 2001). They are an important part of European cultural heritage (Tarolli, Preti and Romano 2014). Several areas with terraces are listed on UNESCO's World Heritage List; for example, Cinque Terre in the Liguria region and the Amalfi coast in Campania, Italy, the Tramuntana mountain range in Majorca, Spain, the Alto Douro region in Portugal, and the Causses plateaus and the Cévennes range in southern France (UNESCO … 2015).

Even though the Mediterranean terraces have long been a part of the landscape, they were not constantly used. Periods of building and expanding were followed by periods of stagnation, abandonment, and regression (du Guerny and Hsu 2010). It is still not entirely clear when the present-day landscape was shaped. It is mostly connected with the last expansion in the eighteenth and nineteenth centuries (Contessa 2014).

The total area of terraced land in the Mediterranean is unknown, and therefore some believe terraces are »widespread but cartographically invisible heritage« (Varotto and Ferrarese 2008). In some parts of Majorca, terraced land covered more than 70% of the territory, and even 100% in some parts of the province of Alicante in Spain (Lasanta et al. 2013). In Tuscany, Italy, for example, terraced land covers 4.5% of the entire territory (Agnoletti et al. 2015).

The beginning of building terraces in the Mediterranean is connected with the shortage of land suitable for farming because the landscape there is very diverse. This was therefore the best possible adaptation to the configuration of the land. Terrace construction was accelerated by population growth. However, this was not the only reason. It was safer to build settlements on elevated land, far from the plains in the valleys, and thus they built terraces on nearby slopes (du Guerny and Hsu 2010)

There are at least three types of terraces in the Mediterranean: parallel (step) terraces are built in straight lines along slope contour lines, braided (switchback) and pocket terraces are usually built around individual trees (both allow the cultivation of cereals, vegetables, legumes, grapes, and olives, as well as grazing), and the third type is used mainly for olive groves (Moody and Grove 1990; Contessa 2014).

LEMONAKIS ANTONIS, SHUTTERSTOCK

In Greece, the most terraces are found on islands, but they are increasingly being abandoned due to population aging and failure to adapt them to mechanical cultivation.

JAKA ORTAR

A terraced landscape with meadows and pastures interspersed with piles of cleared rock below Mount Lovćen in Montenegro.

Villagers usually built terraces together in late fall or winter, year after year, and eventually they terraced an entire area. Mostly they used dry stone wall construction, although earthen terrace slopes are also found. Some estimate that, when preparing the land and stones for dry stone walls, in a day one person could build a dry stone terrace wall 2 to 4.5 m long and 1 m high. Others estimate that a group of ten villagers, with the help of children, could build around 1,000 m of terrace walls in fifty days. They needed fifteen days to prepare, and ten days to rest and do other tasks, and so they built around 20 m of wall per day. Terrace maintenance was, and still is, a task connected to removing plants that damage walls, replacing stones in walls when needed, managing water, and preventing landslides on the slopes (du Guerny and Hsu 2010).

Especially northern Europeans perceive the Mediterranean terraced landscapes as romantic, even idyllic, because they see them as sunny hills with vineyards, olive trees, and citrus trees. The truth is that building and maintaining terraces is exceptionally arduous work offering only a small chance for people to escape poverty (Rolé 2007).

Terraced landscapes in the Mediterranean reached their peak in intensity of cultivation at the beginning of the twentieth century. A period of strong regression followed because of social restratification and a smaller population after the First World War, and therefore a shortage of the labor needed to maintain the terraces. Initially people abandoned terraces on steeper slopes and more remote terraces. In the decades after the Second World War, they were abandoned because of people moving from villages to towns and littoralization (du Guerny and Hsu 2010; Tarolli, Preti and Romano 2014).

With terraces, the land is »artificially« maintained and therefore their abandonment increased slope instability (terrace deterioration and erosion) and led to regrowth of trees of little economic value. This caused a loss of biodiversity and increased the danger of forest fires (du Guerny and Hsu 2010; Stanchi et al. 2012; Contessa 2014). Twentieth-century urbanization also played a part, and many terraces around settlements disappeared. The common agricultural policy of European Union initiatives to intensify farming is not beneficial for maintaining traditional land cultivation. Terraced landscapes have not been able to compete with market-oriented agriculture, and often this led to their removal in order to facilitate use of agricultural machinery to work the land. Therefore, in many places, farmers do not work the land horizontally anymore but vertically, which leads to increased erosion (du Guerny and Hsu 2010).

Terraced landscapes that found a niche in monocultures of grapes, olives, or flowers have been economically successful. Many farmers decided to not only grow grapes and olives, but also set up wineries and olive presses. The survival of terraced landscapes is also encouraged by tourism; they are recognized as a tourist attraction. Subsidies and suitable fiscal policy also contribute to their preservation. However, monocultures and mechanized cultivation have increased their vulnerability to pests and created a higher need for pesticides, and also increased sensitivity to periods of conjuncture and periods of low demand (Agnoletti et al. 2015; du Guerny and Hsu 2010).

Terrace construction and maintenance are no longer communal work, but the responsibility of their respective owners, and therefore the costs are high because they need to hire contractors. In the Cinque Terre region, building a 100 m wall would cost approximately €140, which amounts to almost a billion euros for the existing 6,720 km of dry stone wall, and so concrete walls have started to replace stone walls in many places (du Guerny and Hsu 2010).

Terraces have been abandoned in many places in the Mediterranean. In Tuscany, at least a third of terraced areas have been lost over fifty years due to the lack of maintenance, at least a tenth are being overgrown (Tarolli, Preti and Romano 2014), a little less than a third have been lost in southeastern Spain, the agricultural terraced area in Catalonia has been halved since the middle of the nineteenth century, mainly because of the abandonment of vineyard terraces on steep slopes (Stanchi et al. 2012), only 5% of Iberian mountain terraces are still being cultivated (Lasanta et al. 2013), and it is believed that 85% of the terraced area on the Greek island of Lesbos has deteriorated (García-Ruiz and Lana-Renault 2011).

SEAN MUNSON, FLICKR

Abandoned agricultural terraces with dry walls above an abandoned village in the Tarn Valley in southern France.

A terraced landscape becomes especially dramatic in the Alps, where agricultural terraces, like these found in the Rhone Valley, appear under favorable climate conditions where the influences of the Mediterranean climate extend upward along the valleys. SHUTTERSTOCK


THE ALPS

Agriculture helps shape the cultural landscape in mountainous regions, where agricultural terraces are relatively common because of the steep slopes. In the Alps, especially in the extensive Alpine foothills, terraced landscapes are more characteristic in the south because of its connection to the Mediterranean cultural environment.

Terrace farming is a perfected farming system that makes possible intensive use of slopes with rugged terrain. Terraces in the humid and cold Alpine climate were built on even steeper slopes than those built in drier and warmer areas. The majority of Alpine terraces are on the southern, southeastern, and southwestern slopes. They are mainly located near settlements and at the bottom of the hills, rising above valleys and basins. They were built on slopes that were too steep to easily farm, or where ordinary farming would have even been impossible, but at the same time not so steep for erosion to hamper or even prevent farming. Terrace farming greatly depends on water, and therefore people regulated the amount of water and drainage by building an inventive system of supply and drainage channels, or tilting terrace platforms toward or away from the slope. Correctly constructed terraces prevent rapid water drainage, which has a double effect: they retain water during droughts and reduce erosion during periods of rain (Hrvatin, Perko and Petek 2006; Ažman Momirski et al. 2008).

Terrace construction in the Alps is connected with traditional land use. Many terraces are located in areas where farming is a family business. Terraces are characteristic of this region and are an important part of the landscape identity, and so they were maintained even when it was not considered economical to do so. They are seen as only a historical

SHUTTERSTOCK

The influences of the Pannonian climate extend from the northeast into the Alpine foothills, and so grapevines also thrive there. This is the case in the Austrian Wachau Valley along the Danube, where the terraced landscape and other heritage was added to the UNESCO World Heritage List.

SHUTTERSTOCK

The terraced landscape of Laveaux on the sunward northern shore of Lake Geneva is also on the UNESCO World Heritage List.

JAKA ORTAR

In many places in the high reaches of the Alps there is a kind of inverse terracing, which is being created by routes for farm equipment that run across the slopes in the direction of the contour lines.

JAKA ORTAR

In East Tyrol in southern Austria, grass terraces supported by low walls were created to mitigate the steepness.

RENATE DODELL, FLICKR

Grassed-over tilled terraces with partially overgrown slopes in the southern foothills of the Bohemian Forest in Lower Austria.

remnant in places, and so they are deteriorating (New Insights … 2009; Kizos et al. 2010; Wymann von Dach et al. 2013).

Farmers' average income in the European mountains is around 40% lower than in the plains (Eickhout et al. 2007), and so they have invested additional earnings from grazing in mountain pastures in maintaining terraces. Terraced areas are internally connected with nearby intensively cultivated farmland and also with remote land used for extensive animal husbandry; that is, mountain pastures. Two types are distinguished in relation to construction material: terraces with stone and earthen slopes. In terms of their origin, there are two main types of terraces. The first are intentionally built terraces; these are mainly vineyard terraces, with mainly stone slopes in the Alpine area. The second are tilled terraces with mainly earthen slopes. On terraces in or on the edges of the Alpine foothills, mainly grapes and fruit were grown, and so vineyard and orchard terraces predominate, with also a few tilled and garden terraces. The types of terraces are often mixed; for example, vineyard-tilled or orchard-garden terraces. The oldest ones are the agricultural terraces characteristic of higher elevations; these are mainly overgrown with grass today, but were tilled when subsistence farming was dominant (Titl 1965; Hammad and Borresen 2006; Ažman Momirski and Kladnik 2009).

The oldest terraces can be traced back to the Neolithic. Significant improvement to their construction was made in the eighth century. New techniques to prevent soil erosion were developed around the twelfth century, and terraced areas became an important feature in some regions during the Renaissance, in the fourteenth and fifteenth century. Terraces, characteristic of the contemporary Alpine area, were mainly built during the period of traditional farming and population growth between the eighteenth and twentieth centuries (Nicod 1990; Gibson 2001).

Constructing and maintaining terraces was one of the most difficult tasks for farmers because all of the work was done manually (Bonardi 2008). A large labor force was needed to maintain the terraces and to cultivate and harvest crops, and so terraces were also dependent on the size of the population. The size of the terraced area decreased at the beginning of the Little Ice Age during the sixteenth and seventeenth centuries and increased in the eighteenth century. When a period of agrarian overpopulation followed, terraced areas achieved their maximum size. In the twentieth century, terraces were abandoned because of reduced cultivation, which occurred due to industrialization, social restratification, rural flight, and emigration. This is especially true of Alpine regions, where young people have difficulty with access to good education and employment, and the elderly are affected by loneliness and remoteness. Climate change is also a reason for abandoning terraces because it results in water shortages and more frequent fires (Vrišer 1954; Gabrovec and Kladnik 1997; Lettner and Wrbka 2010; Navarro and Pereira 2012; Valese et al. 2014).

Abandoning traditional farming leads to the disappearance of traditional knowledge and customs. Interestingly, most locals see abandoning terraces as something negative, but visitors often see the regrowth of wild vegetation as something positive (Höchtl, Lehringer and Konold 2005; Ianni, Geneletti and Ciolli 2015). Abandonment of terraced areas in the Alpine region is accompanied by degradation, most commonly soil erosion and slope instability in the form of landslides and consequent debris flow. Degradation is accelerated by heavy precipitation and the lack of support stone walls maintenance. This process is irreversible for now because the land is only rarely cultivated again (Crosta, Imposimato and Roddeman 2003; Komac and Zorn 2005; Zorn and Komac 2007; Gabrovec, Komac and Zorn 2012; Zorn and Komac 2013).

There are many exceptional examples of terraced landscapes in the Alps. The terraced area near the village of Ödenkirchen near Ulrichsberg in Austria covers around 7,600 ha. The terraces at elevations of 590 to 750 m are on the sunny slopes and have been protected since 2002 (Verordnung … 2002). The vineyard area in the Wachau Valley along the Danube River was terraced as early as the ninth century (Our Common … 2015). Picturesque terraces in France are found in the Rhône Valley, the upper course of the Roya River between the towns of Fontan and Saint-Dalmas-de-Tende, and in the narrow Cians and Estéron valleys in the Maritime Alps (Jeddou et al. 2008; Reiner-Ehrig 1980). The terraced landscape in the Valtellina Valley in Italy is increasingly attractive for visitors, with its vineyard terraces covering more than 2,000 ha. Terraces in the Aosta Valley, and also in the Valchiavenna and Bregaglia valleys in the province of Sondrio next to the Swiss border, and Cembra in the autonomous province of Trento, are also well known (Scaramellini and Varotto 2008). Tobacco was grown in the Brenta Valley in the Veneto region and a vast system of terraces with as much as 230 km of dry walls was built in the eighteenth and nineteenth centuries (Alpter 2014). The renowned Swiss vineyard terraces are located along the upper Rhône River before it flows into Lake Geneva, in the Lavaux region east of Laussane on the north coast of Lake Geneva, where terraces were built in the time of ancient Rome and their appearance today was shaped in the eleventh century by the Benedictines (Lavaux 2007), and in the Bregaglia area in the canton of Grisons. To preserve such heritage and to showcase an example of successful sustainable coexistence of nature and society in the last year of twentieth and at the beginning of the twenty-first centuries, the Wachau Valley in Austria (2000) and the Lavaux region in Switzerland (2007) were included on the UNESCO World Heritage List.

Alpine terraced landscapes are increasingly important tourist destinations, and are often connected with viticulture and winemaking (Jean 2003; Guisepelli 2006; Bender 2010; Varotto and Lodatti 2014).

Terraced multi-row vineyards on the steep sunward bank of the Moselle River in Germany have stone slopes that only slightly reduce the gradient of the terrace platforms, which still have a considerable slant, thus reducing soil erosion. SHUTTERSTOCK

WESTERN, CENTRAL, AND EASTERN EUROPE

Terraced landscapes are scattered also throughout western, central, and eastern Europe. The largest terraced area extends along the middle and upper course of Rhine; that is, from Bonn in the north, through Luxembourg and Alsace, to Switzerland in the south. Terraced landscapes and their characteristics are described here from west to east.

In the British Isles, terraces were formerly known as *lynch*, from which the modern expression *lynchet* derives (Terrace … 2016). For the English, this does not refer to a »true« terrace but only to a step on a slope created from long-term plowing and turning the furrows away from the slope (Lynchet 2016). Thus the English do not consider these steps to be terraces like the dry-wall terraces in the Mediterranean or irrigated terraces in monsoon Asia. In Slovenia, these steps are also called agricultural terraces, and the English *lynchets* are probably remnants of the Celtic field system, which took shape on limestone slopes during the Iron Age and Antiquity in Wiltshire and Dorset counties. The remnants from the Middle Ages, when fields were plowed in the open-field system, can be seen more clearly. Former tilled land has been converted into pastures over time (Hooke 2015).

Even though the Netherlands is low and flat, and thus does not offer much opportunity to build agricultural terraces, they are still part of the landscape. They arose on the slopes between the broad plains and plateau area, most often through long-term plowing and gradual leveling of the arable land. It is believed that some were intentionally built for vineyards in the Middle Ages. Slope terraces are drawn on some of the more detailed maps, and they have a specific topographic symbol. Comparative analysis of older and newer maps shows that many terraces were

WOJCIECH LISINSKI, SHUTTERSTOCK

A terraced landscape with abandoned, grassed-over terraces with the beginnings of overgrowth in the Little Pieniny, a range northwest of the Tatras in extreme southern Poland.

MIKE BARRATT, WIKIMEDIA COMMONS

Terraces known as lynchets above the village of Bishopstone in Wiltshire County in southern England.

SHUTTERSTOCK

This hilly terraced landscape in Slovakia where terraces are still being actively tilled was primarily created by plowing.

SHUTTERSTOCK

Slopes with indistinct terraces in a mountain valley in Transylvania, which is the most terraced region in Romania.

DOBRIN MINKOV, SHUTTERSTOCK

This landscape with tilled terraces in Bulgaria reveals the former character of such terraced landscapes in Europe.

removed (Renes 2015). The majority are located in the hilly Heuvelland area in the southernmost province of Limburg. The inclined earthen slopes are more than 1 m high and in places are covered with bushes and fruit trees. The bushes grow so dense in places that they have turned into hedges. Small slumps are frequent where the slopes are bare. The grassy terrace platforms are tilted slightly outwards.

German vineyard and tilled terraced landscapes are located in valleys, on hills, and in the mountains (Kruse and Roth 2015). Vineyard terraces are the best known; the Middle Rhine Valley, between Rüdesheim and Koblenz, was added to the UNESCO World Heritage List in 2002 (Upper … 2002). A smaller area with vineyard terraces is located along the Saale River and its tributary, the Unstrut, southwest of Leipzig. Valleys with vineyard terraces are important not only for viticulture and winemaking, but also for tourism and recreation because they attract visitors from not only far away, but also among those that live in the nearby densely populated mining and industrial area. There are also orchard terraces in Germany.

The terraced landscapes along the Rhine and its tributaries have a special character. Unterraced vertical vineyards alternate with terraced ones, which have characteristic large, greatly inclined slopes supported by tall walls built of shale or some other rock. There are also steps built into the slopes that facilitate access from one terrace platform to another. Grapes are planted in horizontal and also vertical rows on small earthen terraces with platforms that only slightly modify the incline of the steep slope.

The modern terraced landscape in Kaiserstuhl, located on a range of hills of volcanic origin in the German state of Baden-Württemberg, is especially interesting. The soil in the area is very susceptible to erosion, and therefore the slopes intended for vineyard and orchards had to be terraced; however, this did not occur until the 1950s. The terraces were constructed for mechanized cultivation and modern access roads were built, which were gradually widened, connected, and made more regular, and so the entire slope was transformed. Their slopes are over 10 m tall, the platforms on the gentler slopes are very wide with space for more than ten rows of grapevines, and the platforms on the steeper slopes are narrower; however, there are still several rows of grapevines on them. Initially, the terraces were created manually and with little mechanization, and later on with mechanization and increasingly heavier and more powerful construction equipment. During the penultimate phase, in 1970 to 1976, the area of terrace slopes and access roads was almost greater than the area where grapevines were planted. The winemakers opposed this, and in the last phase of terrace construction from 1976 to 1982 the slopes had to be less than 10 m tall, and the shape of the terraces had to follow the shape of the terrain. The terrace width narrows in ravines and significantly widens on intermediate shelves, and this is strongly reminiscent of the picturesque landscape with rice terraces in southeastern Asia. The terraces were carefully constructed; however, extreme weather events periodically cause significant damage, such as landslides and slumps. Less forest cover and larger platforms result in more frequent frost, which is especially damaging to the vineyards at the lower elevations (Kaiserstuhl 2016).

A smaller area of terraced vineyards can be also found in the Czech Republic. Modern vineyard terraces are more common on the hilly edges of the Pannonian basin, especially in southern Slovakia, eastern Slovenia, northern Croatia, and to a smaller degree in northeastern Hungary and western Romania; in contrast, modern vineyards in eastern Austria and northern Serbia are not terraced. Orchard terraces are relatively common in Hungary; where the well-known Tokaj wine region, which is included on the UNESCO World Heritage List, is located (Tokaj … 2002). The tilled terraces that were built in the Middle Ages and have slopes made of earth or stone have largely been abandoned and have deteriorated (Centeri 2015).

Traditional tilled terraces are common in northern Slovakia, on the foothills of the Great and Little Fatra mountains, in the Low and High Tatras, and in the Pienin and Beskid mountains along the border, where similar terraces continue into interior of Poland. Terraces are well preserved in the areas where traditional extensive farming was not affected by the forced collectivization after the Second World War and are still used to a considerable degree. The terraces were either intentionally created with more level platforms and distinct slopes, or were created through long-term plowing and have tilted platforms and low, less-distinct slopes. The traditional jigsaw-like terraced landscape on the hillsides with its mix of fields, meadows, orchards with standard-sized trees, and small vineyards, especially in the areas with abandoning land, is rich in biodiversity (Špulerová, Dobrovodská and Štefunková 2015).

Mixed traditional extensive farming is preserved in the Romanian and Bulgarian hills, and therefore the majority of terraces there are still cultivated. Tilled terraces are especially common in Romania's Transylvania and Maramureș regions, where former predominant fields has now almost everywhere turned into meadows. Vineyard terraces were created manually and with the help of mechanization after 1950. They are also relatively common, varying in origin and type, in the southern foothills of the Transylvanian Alps and the karst Dobruja region in far eastern Romania (Brinduse and Pircălabu 2016).

TERRACED LANDSCAPES IN SLOVENIA

Although Slovenia does not possess the world's most recognized landscapes with irrigated terraces for cultivating rice, its terraced landscapes are varied enough to deserve attention and discussion, through which we aim to present their structure and set out the elements that distinguish them from one another. Their diversity greatly depends on natural landscape types, which is why the following chapter is dedicated to them. Slovenia is also considered a veritable landscape hotspot on a global scale (Ciglič and Perko 2013, 2015).

Diverse terraces form a typical cultural landscape as an important cultural value and are also a cornerstone of certain ones among them. They have a clear added value that can only flourish if they are properly maintained (Ažman Momirski and Kladnik 2015b). Only then can they reveal their attractiveness, which should not only be the pride of the locals that live with terraces from generation to generation, but may prove to be an important potential for development if they are appropriately managed in the future.

However, diversity itself does not guarantee attractiveness because interested visitors can only recognize this after visiting several such areas and comparing them. To activate this potential, it is necessary to intensify cultural landscape protection as an important part of Slovenian heritage and to ensure sufficient development. In many places, this could serve to promote the development of tourism, which should primarily market the diversity of Slovenia and its landscapes, also focusing on the significant diversity of Slovenian terraced landscapes that this book seeks to present.

Slovenia and its exceptional landscape diversity are crisscrossed by terraces like few other European countries. They occur in all types of landscapes, but differ in their frequency,

MATEVŽ LENARČIČ

A typical Mediterranean terraced landscape near Padna in the Koper Hills.

MATEVŽ LENARČIČ

A typical Pannonian terraced vineyard landscape in the Slovenian Hills.

◀ Ena najbolj privlačnih slovenskih terasiranih pokrajin se razkriva pod vasjo Ostrožno Brdo v Brkinih, vendar je ustrezne ustanove še niso prepoznale kot vredno varovanja, kar pa bi bilo treba čimprej zagotoviti, saj je zaradi neugodnih demografskih tokov močno ogrožena. MATEVŽ LENARČIČ

purpose, and modern role (Ažman Momirski and Kladnik 2009). Given the fact that they have quite distinctively marked the landscape in many parts of Slovenia, and in some places even dominate it, it is unusual that significant research attention has been devoted to them only recently.

First terraces are likely to have already been created in the Roman era (Gaspari 1998) because it is otherwise difficult to imagine cultivating grapevines and olive trees, which were already the main crops at that time, on the steep slopes. People created terraces in order to adapt agricultural production to natural conditions and to acquire new agricultural land. In less favorable climate conditions, terracing of sunny slopes made possible agricultural production on more profitable land that provided greater yields and better quality. The level terrace platforms facilitated land cultivation. Terrace construction prevented negative effects of erosion, including soil erosion following heavy rains, and also retained more moisture and preserved soil humidity on the terraced land.

When building terraces, people carried out all the work manually, and therefore terrace construction and maintenance was one of the most arduous agricultural tasks. Manual work and the transport of manure and crops demanded a lot of manpower, which was not lacking in the past because the majority of the active population was engaged in agriculture in the era of dominant subsistence and self-sufficient agriculture. In 1771, the proportion of rural population in the territory of what is now Slovenia was 88.6%, and in 1910 it was still considerable, at 66.7% (Natek 1998).

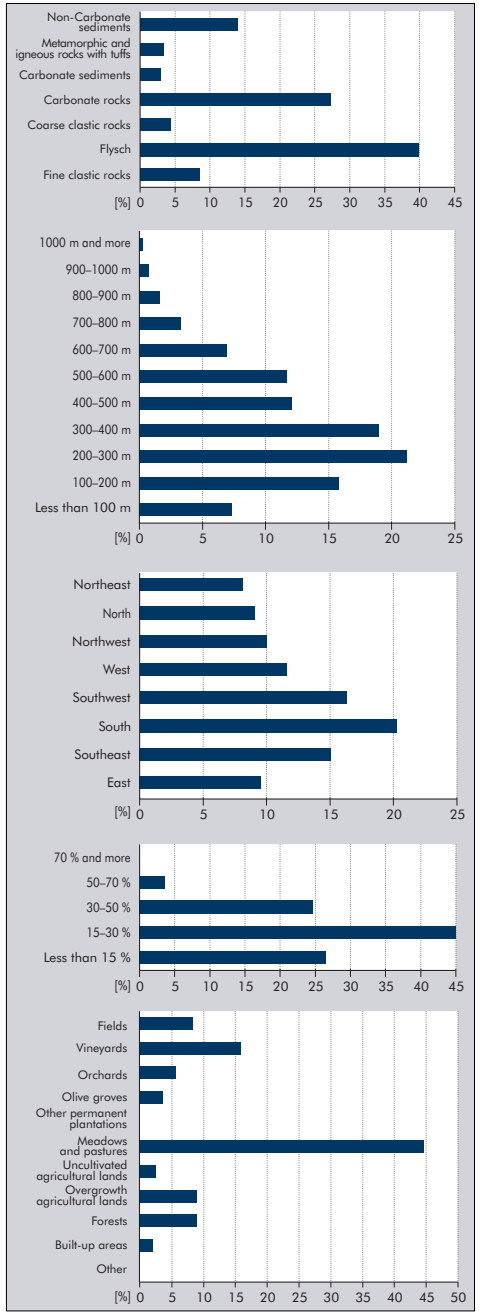
After the Second World War, mechanical terracing and maintenance of vineyards, and of orchards to a lesser extent, corresponded to the expansion of the large communist-era collective farms; this resulted in easier and more profitable agriculture on steep slopes of all wine-growing regions. In eastern Slovenia, terracing was a completely new phenomenon. Data indicate that the first terraced plantation in the Podravje wine-growing area was created in the settlement of Gruškovec in the Haloze Hills as early as 1892–1899 (Bračič 1967). Belec (1968) states that the first terraced vineyards after the Second World War appeared in 1957 and that large-scale terracing completely altered the landscape.

The transition from manual to mechanized terrace construction and maintenance fundamentally changed their form and appearance. With manual construction and maintenance of the terraces, the width of the platforms differed considerably: some were narrower, some were wider, and their length also varied. Using agricultural machinery made the platform width and the height of the terrace slopes much more uniform. Earthen slopes without retaining walls became dominant. Moreover, the terraces are connected by farm roads and turning places for agricultural machinery. By using a uniform terrace model, the landscape became geometrical and more regulated (Ažman Momirski et al. 2008), which affects its harmony. Contemporary Slovenian terraced landscapes are among the most attractive cultural landscapes, with a strong cultural and symbolic value.

Cultural heritage protection experts have become aware of this fact, and so increasingly more terraced landscapes have been included in the Ministry of Culture's Registry of Immovable Cultural Heritage. The category of cultural landscape includes 318 items, and terracing can be considered an important element of thirty-two among them. In two cases, the terraces were the decisive reason for their entry into the register, in seventeen it is an important reason, and for another thirteen terraces are not explicitly mentioned, but the description clearly states their significant role. The greatest number of registered units of terraced cultural landscapes are found in the Koper Hills (*Koprska brda*) (ten) and the Sava Hills (*Posavsko hribovje*) (eight), three are in the Lower Carniola Lowland (*Dolenjsko podolje*), two in the Gorjanci Hills (*Gorjanci*), and one in each of the following: the mesoregions of Boč Hill and Macelj Hill (*Boč in Macelj*), the Ljubljana Marsh (*Ljubljansko barje*), the Kambreško Hills and Banjšice Plateau (*Kambreško in Banjšice*), the Krim Hills and Menišija Plateau (*Krimsko hribovje in Menišija*), Little Mount, the Kočevje Rog Plateau and Mount Poljane (*Mala gora, Kočevski rog in Poljanska gora*), the Radulja Hills (*Raduljsko hribovje*), the Slovenian Hills (*Slovenske gorice*), Dry Carniola (*Suha krajina*), and the Velike Lašče Region (*Velikolaščanska pokrajina*).

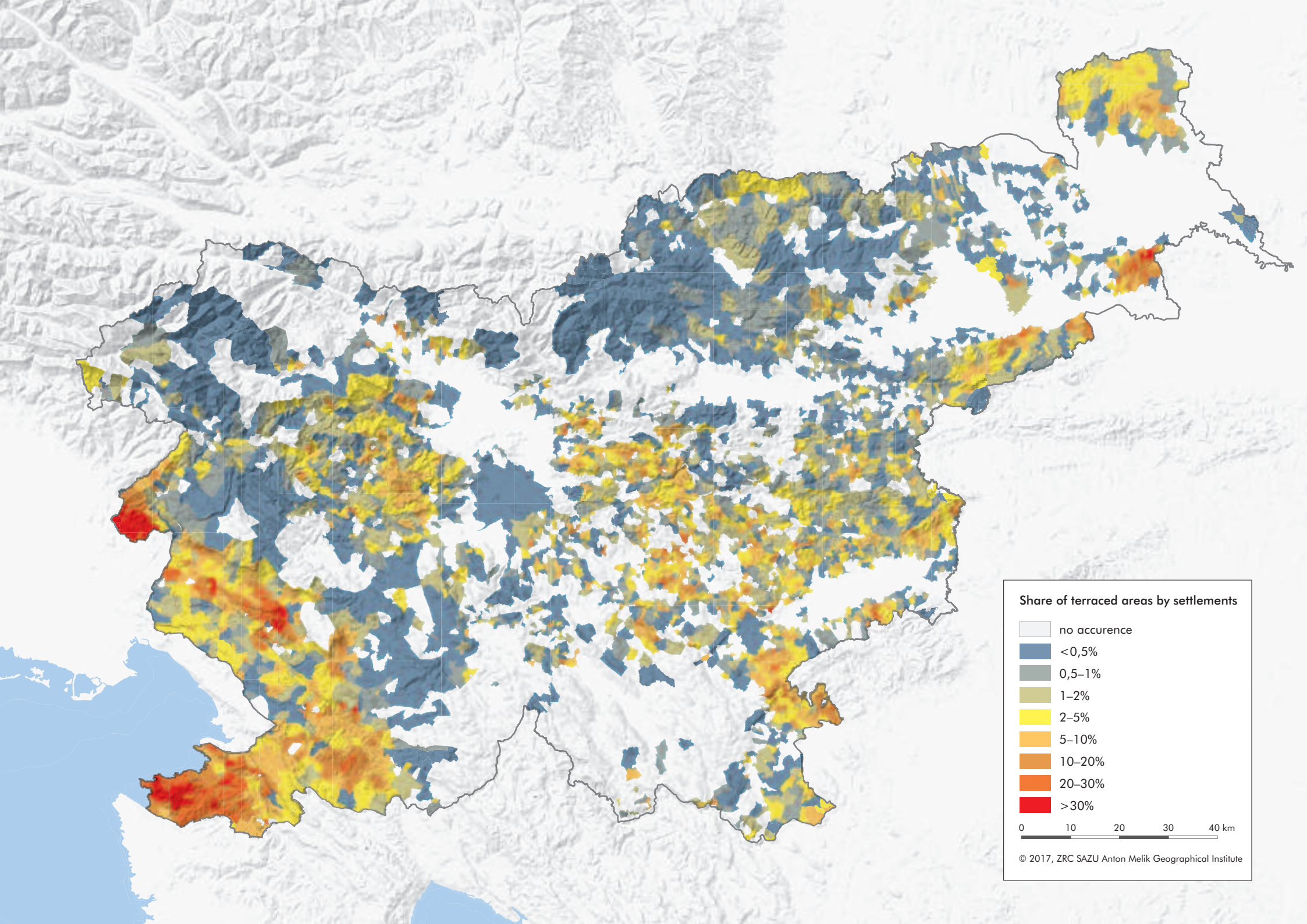
Knowing the actual situation throughout Slovenia, it can be stated that the existing list of units under protection is inadequate. It also shows insufficient criteria for inclusion and partly terminologically incomplete descriptions of protection justifications, which indicates a significant lack of awareness and poor recognition of terraced landscape values among the professionals responsible for setting out the strategy and the protection plans as well as the professional justifications for units included. The cultural landscapes in Slovenia, and the terraced landscapes within them, are also still not identified as part of intangible heritage, although certain practices and economic knowledge of working terraced land certainly pertain to this type of inheritance.

Nowadays, the traditional centuries-old agricultural terraces have undergone considerable



Shares of rock, elevation, inclination, and aspect classes and also land use on terraced land.

◀ Slovenia is a country with diverse terraced landscapes that at first glance are usually not immediately apparent; however, when the eye focuses on the pattern of terraced slopes and platforms, one sees them almost everywhere, such as in Podkum in the Sava Hills. MATEVŽ LENARČIČ


Share of terraced areas by settlements
no accurence
<0,5%
0,5–1%
1–2%
2–5%
5–10%
10–20%
20–30%
>30%
0
10
20
30
40 km
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MATEVŽ LENARČIČ

The continued existence of Pannonian terraced landscapes is threatened most by the conversion of terraced vineyards into vertical plantations of vines, such as at the Zlati Grič vineyards above the town of Slovenske Konjice.

MATEVŽ LENARČIČ

Terraced landscapes are also threatened by the abandonment of tilled land, which leads to overgrowth, as it is evident from the example of abandoned vineyard terraces in the wooded Western Haloze Hills.

abandonment. However, their abandonment is not a new phenomenon because Vrišer (1954), Melik (1960), and Titl (1965) already reported the extensive abandonment of terraces in the northern Gorica Hills (*Goriška brda*) and the Koper Hills. Various reasons contributed to their abandonment. Industrialization and abandonment of farming diminished the role of agriculture, and globalization contributed a completely new dimension. Alongside rural flight, social restratification, population aging, and a general agricultural labor shortage, terraces started losing their former role and extensification started appearing instead (Ažman Momirski and Kladnik 2015a). In many places, this was followed by afforestation and the gradual deterioration of the terraces, thus leading to the destruction of the traditional landscape, which was marked to a significant extent by traditional Slovenian terraced landscapes. It is clear that the lack of agricultural labor can only be replaced by machinery. However, building access routes is essential for its implementation (Titl 1965; Kladnik 1990). After Slovenia's independence, the high renovation costs for terraced vineyards raised doubts about their legitimacy and reasonableness. Many of the terraced vineyards were abandoned and have since been deteriorating because of unregulated ownership. Many have already been turned into more profitable vertical vineyards. Abandoning the terraces causes the landscape to lose its unique characteristics, and thus a number of other opportunities tied to the development of tourism.

Attention should also be drawn to the interesting modern phenomenon of inverse terraces, which are characteristic of higher elevations. The terracing look is typically achieved by the parallel access routes for agricultural machinery running along the contour lines, which then form a sort of narrow terrace platforms, while the usually grassy wider parts in-between represent the terrace slopes which are in fact part of hillslope with unchanged gradient.

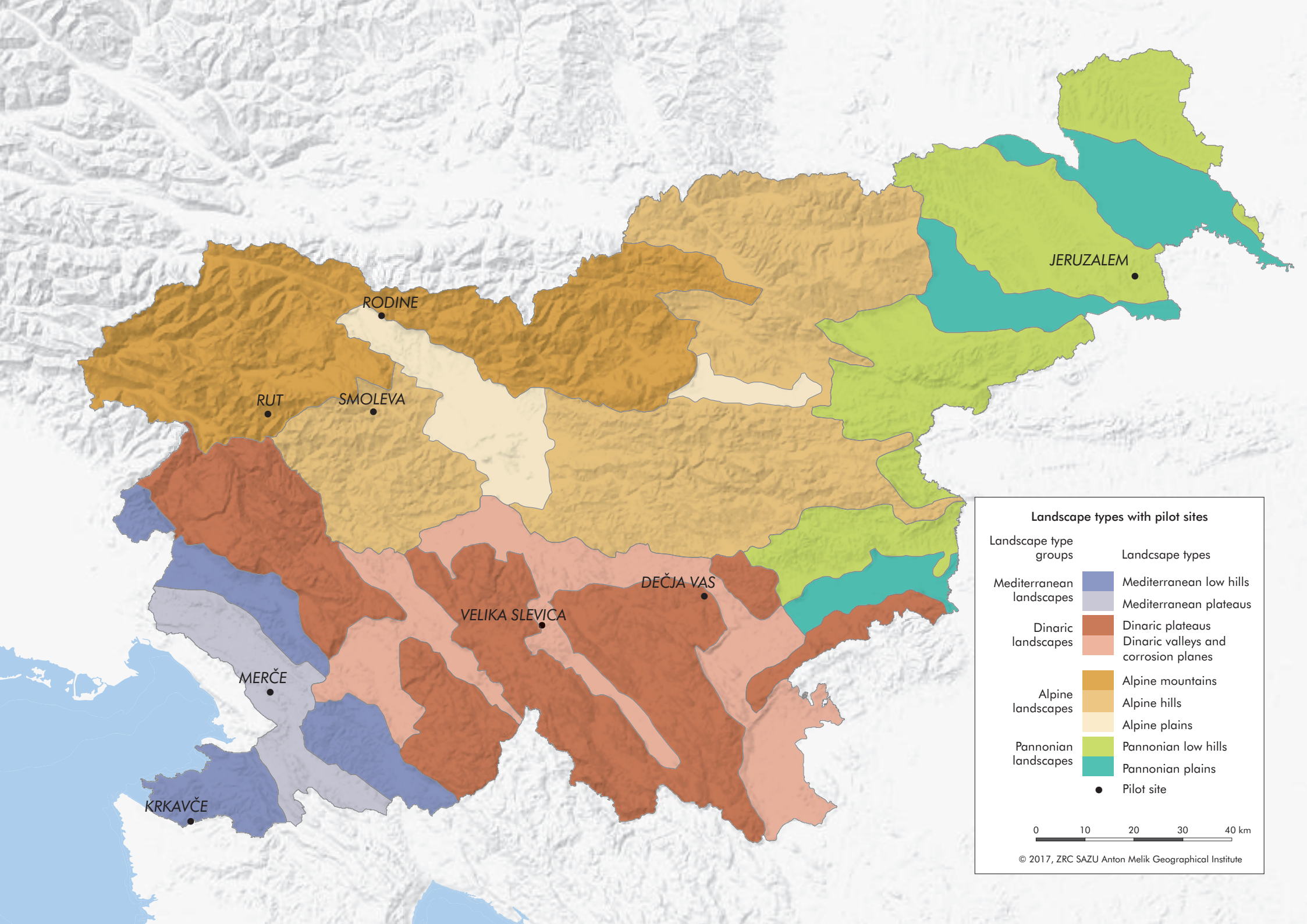
In Slovenia, terraces cover 1.71% of the territory. The majority are in the Mediterranean regions (8.96%), and elsewhere the proportion is below average: 1.32% in Pannonian regions, 0.99% in Dinaric regions, and 0.91% in Alpine regions. The most terraced are three Mediterranean mesoregions; terraces cover 26.0% of the territory in the Gorica Hills, 17.8% of the Koper Hills, and 10.3% of the Vipava Valley (*Vipavska dolina*).

The terraces in Slovenia appear at elevations ranging from sea level to nearly 1,200 m (the Bukovnik farm, which has the highest elevation in Slovenia, is at 1,327 m); however, the majority of terraces in terms of area are found at elevations ranging from 200 to 300 m (21.2%), from 300 to 400 m (19.0%), from 100 to 200 m (15.8%), and from 400 to 500 m (12.1%). Altogether, 39.8% of terraced land is on flysch, 27.3% on carbonate rock (dolomite and limestone), and 13.9% on non-carbonate sediments. Almost half (45.0%) are positioned on moderate slopes with a gradient of 15.1 to 30.0%, a quarter on gentle slopes with up to a 15.0% gradient, and another quarter on steep slopes with a gradient of 30.1 to 50.0%. Most Slovenian terraces have a south and southwest exposure (20.2 and 16.3%, respectively), and the fewest have a northeast and north exposure (8.1 and 9.1% respectively). Today, the majority of terraced land is used for meadows and pastures (44.6%), followed by vineyards in a substantially smaller proportion (15.7%). Fields occupies 8.2% of terraced land, orchards 5.6%, and olive groves 3.6%. 2.4% of terraced land is not cultivated

◀ The share of terraced land by Slovenian settlements area in 2015.

In Dry Carniola, the upper slopes in Šmaver have unterraced vineyards, below which lie tilled terraces; they clearly stand out in winter, when the sun melts the snow on the risers. MATEVŽ LENARČIČ ▶

In Gorca in the Haloze Hills, the upper parts of hills facing the sun have terraced vineyards. Each terrace step has a single row of vines due to the steepness. MATEVŽ LENARČIČ ▶▶


JERUZALEM
RODINE
RUT
SMOLEVA
DEČJA VAS
VELIKA SLEVICA
MERČE
KRKAVČE
Landscape types with pilot sites
Landscape type groups
Landcsape types
Mediterranean landscapes
Mediterranean low hills
Mediterranean plateaus
Dinaric landscapes
Dinaric plateaus
Dinaric valleys and corrosion planes
Alpine landscapes
Alpine mountains
Alpine hills
Alpine plains
Pannonian landscapes
Pannonian low hills
Pannonian plains
Pilot site
0
10
20
30
40 km
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MATEVŽ LENARČIČ

Depopulation is causing overgrowth of terraces in Ostrovica in the Brkini Hills.

MATEVŽ LENARČIČ

A miniature terraced landscape near Vrbje in the Gorjanci Hills.

◀ The division of Slovenia into the landscapes dealt with in this volume.

any more, 9.0% is already overgrown with shrubs and trees, and 8.9% has undergone complete afforestation. In fact, the terraced area that has already been overgrown by forest is considerably larger because certainly not all terraces were able to be registered when digitizing DOPs.

Terraces are a fascinating element of Slovenian cultural landscapes. They are distinguished by their integration into the natural environment and are thus as varied as the Slovenian landscapes.

Only a few countries, even much larger ones, can compare with Slovenia in terms of landscape diversity because it is exactly on its small territory in central Europe that the Mediterranean, the Dinaric mountains, the Alps, and the Pannonian basin as well as Slavic, Romance, Germanic, and Hungarian cultural influences meet and intertwine (Kladnik, Perko and Urbanc 2009). Slovenia is also a landscape hotspot of Europe because it has the greatest average landscape diversity of any European country (Ciglič and Perko 2013; Ciglič and Perko 2015).

There are nine landscape types and four groups of landscape types. The types are: Mediterranean hills, Mediterranean plateaus, Dinaric plateaus, Dinaric valleys and corrosion plains, Alpine mountains, Alpine hills, Alpine plains, Pannonian hills, and Pannonian plains. The groups of types are Mediterranean, Dinaric, Alpine, and Pannonian landscapes (Perko, Hrvatin and Ciglič 2015).

Mediterranean Landscapes

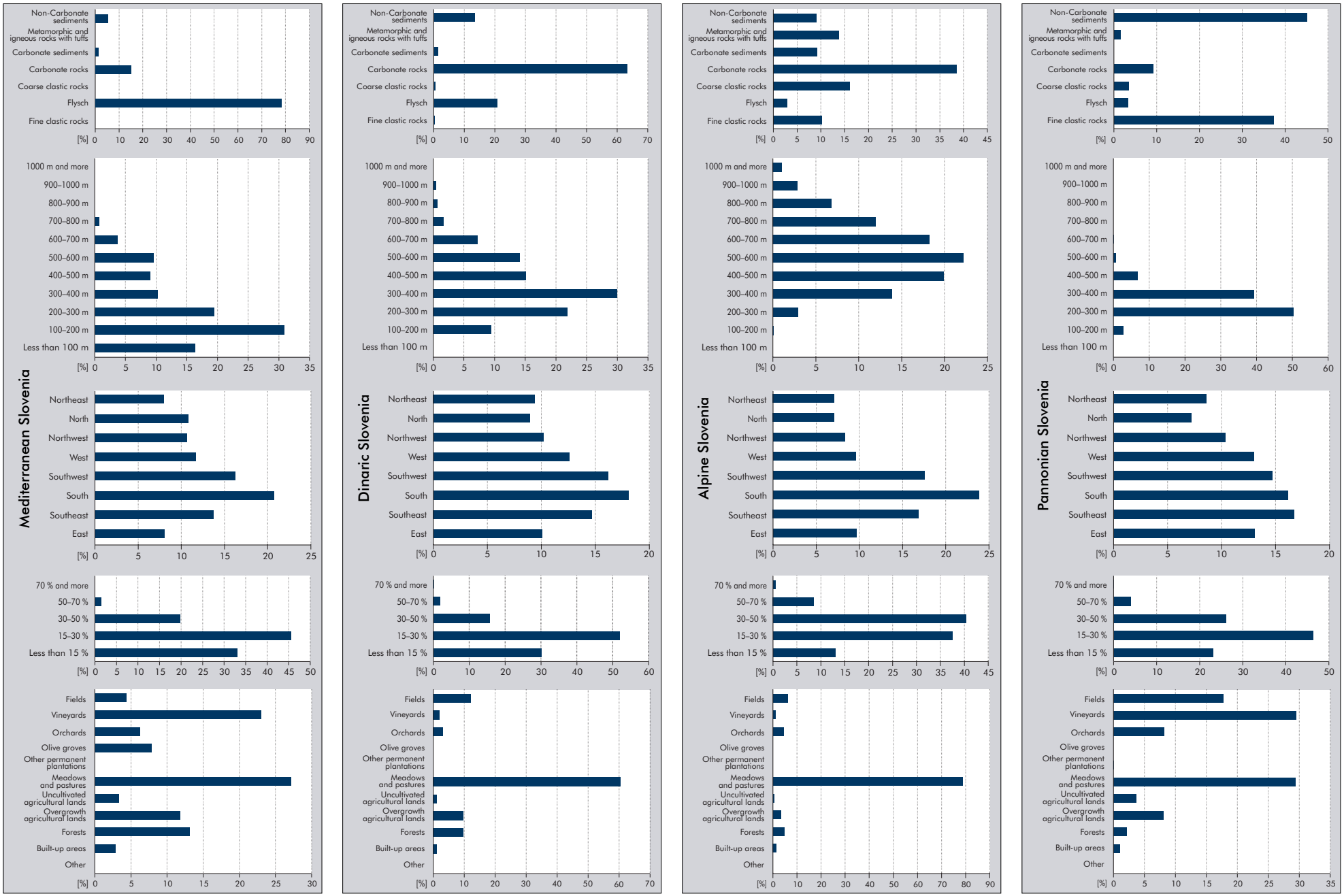
The Mediterranean is the area surrounding the Mediterranean Sea. Gibraltar and Beirut are about 3,700 km apart, and Trieste and Durrës on the Adriatic Sea, which stretches along the Italian Apennines to the southwest and the Dinaric Mountains to the northeast, are almost 700 km apart. The Adriatic Sea, which covers 132,000 km^2, is slightly larger than the Dinaric Mountains. Slovenia is located on the northern periphery of the Mediterranean. Mediterranean landscapes are found southwest of the Dinaric landscapes and cover nearly a tenth of Slovenia. Here, one finds typical Mediterranean villages where stone buildings usually stand next to each other. The most prominent clustered settlements are built on top of hills.

The Mediterranean low hills are mostly formed of flysch. Increasingly more olive trees are grown on agricultural terraces, but vineyards and orchards are heavily overgrown in some places. In the extreme south, the hills extend to the barely 47 km-long Slovenian Adriatic coast, where the population and various activities are concentrated as well as three cities with typical Mediterranean centers. The Bay of Piran cuts most deeply into the mainland.

The sparsely populated **Mediterranean plateaus** are almost entirely made of limestone and are therefore markedly karstified. They receive the largest amounts of solar radiation in Slovenia because the annual average reaches almost 4,400 MJ per m^2.

Dinaric Landscapes

The **Dinaric Mountains** are the southeast continuation of the Alps between the Pannonian Basin and the Adriatic Sea. They separate the waters of the Black Sea and the Adriatic watershed. The mountains are about 700 km long and almost 200 km wide in the central part. Their area is less than half of the Alps' area. The northwest part of the Dinaric Mountains extends to Slovenian territory. South of the Alpine and Pannonian regions,



Shares of rock, elevation, inclination, and aspect classes and also land use on terraced land.

the Dinaric landscapes extend from northwest to southeast, occupying most of the southern part of Slovenia. The magical subterranean world created by the water is quite a contrast to the inhospitable surface. More than ten thousand caves with stalactites and other cave formations have been discovered underneath the Dinaric and neighboring Mediterranean karst landscapes.

The Dinaric plateaus are almost entirely made of limestone and dolomite. They are the most forested area in Slovenia, with forest covering almost three-quarters of its area. Surface water is rare. Droughts and forest fires are frequent. Small clustered settlements with irregularly located buildings dominate the area. Due to adverse natural conditions, farmers make their living from forestry and animal husbandry. The population density is six times smaller than the Slovenian average and still decreasing.

The Dinaric valleys and corrosion planes, where the forest has overgrown another two-fifths of the area, extend among the karst plateaus. The corrosion planes mostly consist of limestone and dolomite, and in the valley systems some clay and flysch can also be found. Some of the valleys are very important for the transport network.

Alpine Landscapes

The Alps are the largest and highest mountain range in Europe. The main watershed divide between the North Sea and the Mediterranean Sea, and the climatic boundary between the continental and Mediterranean climates runs along them. Their area exceeds 200,000 km^2. The Alps are over 1,200 km long and in some parts up to 250 km wide. They extend from France in the southwest to Austria in the northeast. The southeast part of the Alps extends to Slovenia. Alpine landscapes occupy two-fifths of its territory.

The Alpine mountains primarily consist of limestone and dolomite. Rivers have carved deep valleys that were transformed by glaciers during the ice ages. Forest covers four-fifths of the area below the tree line at an elevation ranging from 1,600 to 1,900 m (Lovrenčak 1987). Only broad valleys and small basins are densely populated, whereas extensive mountain areas are completely uninhabited. The population is growing only slightly.

To the south and east, **the Alpine hills** surround the Alpine mountains in a wide arc. They are mainly consisted of dolomite, limestone, metamorphic rock, claystone, siltstone, quartz sandstone, and conglomerate. Forest covers two-thirds of the area. The population density is twice as high as in the mountains. The characteristic type of settlement is an isolated farm where a large house and outbuildings are surrounded by cultivated land in one piece carved out of the forest. Elsewhere, nucleated villages with clustered buildings one next to another were built; the same is true of agricultural land.

The Alpine plains were formed by the rivers that deposited gravel and sand, thus forming river terraces at the bottom of basins. Older terraces, where conglomerate was formed through the consolidation of gravel, become karstified and overgrown with trees. Fertile fields, however, are expanding on more recent gravel terraces. Arable land occupies one-quarter of the entire area. The clustered settlements on the plains are large and highly urbanized. The population density is six times greater than the national average.

Pannonian Landscapes

The Pannonian Basin spreads out between the Alps to the west, the Carpathians to the north and east, and the Dinaric Mountains to the south. Measuring about 600 km from north to south, and 700 km from west to east, its area is almost twice that of the Alps. The southwest margins of the Pannonian Basin extend to Slovenia. Pannonian landscapes, which account for one-fifth of Slovenian territory, are densely populated and intensely cultivated, and forest covers less than one-third of the territory.

The winegrowing **Pannonian low hills**, which meet the Alpine hills to the west, consist of poorly consolidated rock, mainly marl, sand, and clay, which creates a great danger of landslides. Scattered settlements with agricultural land among the houses dominate the area. The houses are most often built on the tops of rounded ridges. Below them, vineyards and orchards lie on the sunny slopes, whereas forest prevails on the shady slopes, covering over one-third of the territory. The population is slightly declining.

The large, agriculturally important, but flood-prone **Pannonian plains** extend among the hills, along the meandering and gently flowing Mura, Drava, and Krka rivers, where many mills used to operate. Forest covers less than one-fifth of the territory, which is the lowest rate in Slovenia, and can be found only in frequently flooded areas. In order to use the agricultural land more efficiently, people only built homes and outbuildings along the main roads, thus creating large, long linear settlements, where one-story buildings are evenly located on one or both sides of the road. Extensive agricultural land in a strip-field pattern extends behind the houses.

BLAŽ KOMAC

Mediterranean cultural influences travel up the Soča Valley to the Bovec Basin, resulting in stone-reinforced terrace embankments.

MEDITERRANEAN SLOVENIA

Mediterranean landscapes in southwestern Slovenia cover 1,734 km², or about one-tenth of the country's territory. They include flysch hills, which occupy three-fifths of the territory (1,061 km²), and karst plateaus (673 km²). In addition to the alternation of flysch and limestone areas, their main feature is a warm submediterranean climate (Ogrin 1996; Repolusk 1998b).

The population of these areas was 197,405 in 2011 (Registrski popis 2011). The first demographic peak was in 1910, when more than 166,000 people lived there, followed by a decline that lasted until the 1950s, when population growth prevailed again. The general image is essentially true only for the flysch hills, where over 172,000 people lived in 2011. The karst plateaus with 25,000 inhabitants, on the other hand, are always characterized by population stagnation, and the population fell by one-fifth immediately after the Second World War.

In the Mediterranean regions, terraces cover a total of 15,542 ha or 8.69% of the land, which is five times more than the Slovenian average of 1.71%. This percentage is mainly due to the large terraced areas in the Mediterranean regions because the percentage of terraced land is much lower in the other three main types of Slovenian landscapes. The largest percentage applies to the Gorica Hills (*Goriška brda*) (26.0%), the Koper Hills (*Koprska brda*) (17.8%), where its 5,826 ha of terraces exceed that of any other Slovenian mesoregion, and the Vipava Valley (*Vipavska dolina*) (10.3%). The average percentage of terraces in the Mediterranean hills (12.4%) is significantly higher than on the Mediterranean plateaus (3.6%). Almost four-fifths of terraced land is on flysch, and a sixth on carbonate rocks. Half is situated on moderate slopes with a gradient of 15.1 to 30.0%, a third is on gentle slopes with a 15.0% gradient, and a fifth on steep slopes of 30.1 to 50.0%. In terms of elevation zones, less than a third of terraced areas are in the elevation zone from 100 to 200 m, a fifth of them are in the zone between 200 and 300 m, and one-sixth are in the lowest zone, which extends up to 100 m. The highest-elevation terraces are at 900 m. Given the relatively low elevation and favorable climate conditions, it is somewhat surprising that a significantly greater number of terraces are on sunny slopes than on shady slopes. Just over half (50.7%) of terraces are on slopes with a south, southwest, or southeast exposure, and 29.5% are on slopes with a north, northeast, or northwest exposure. At the same time, many more terraces are on west-oriented slopes than on those facing east.

The terraced land is predominantly covered by meadows and pastures (27.2%), which are typical of the tilled terraces where fields used to prevail. This is followed by vineyards (23.1%) on vineyard terraces, which, unlike the Pannonian ones, are much more diverse, planted with one, two, four, and even more varieties of grapes. A significant proportion of terraced land is occupied by olive groves (7.9%) and orchards (6.3%), and fields are very rare (4.4%). The great problem of preserving the Mediterranean terraced landscapes is overgrowth, a process that is currently taking place on 11.8% of terraced land, and at least 13.2% has already undergone afforestation. It was certainly not possible to register all of these in this study.

Terrace farming was almost the only possible way to intensively use the steep terrain of Mediterranean Slovenian territory in the past. This is why the oldest terraces in Slovenia are found here, and certain ones in the Koper Hills probably date back to Antiquity (Gaspari 1998). In recent decades, mainly those terraces that allow mechanical cultivation are being maintained. At the same time, abandoned terraces are being renovated and primarily olive trees are being planted there, whereas in the Gorica Hills and the Vipava Valley vineyard and orchard terraces are being newly constructed. Mediterranean terraced landscapes represent an extraordinarily important cultural value, and thus need to be preserved for future generations. At the same time, alongside the aforementioned vineyard and olive terraces of the Koper and Gorica hills, and the Karst region, special attention should be devoted to the tilled terraces in the Brkini Hills (*Brkini*), which offer an unprecedented experiential value (Ažman Momirski and Kladnik 2015b).

The sample area for the **Mediterranean low hills** is the village of **Krkavče** (191 m), which is an old settlement with a clustered core and compact surrounding hamlets in the extreme southwest part of Slovenian Istria. The area lies in the Koper Hills, north of the Dragonja Valley, and rises up to 274 m at Gradišče Hill (Repolusk 1998a; Pucer 2007). It is characterized by a Mediterranean climate with hot summers and mild winters, during which temperatures usually do not fall below 2 °C. Nonetheless, there is a danger of frost, and so in the past the residents of Krkavče primarily grew Mediterranean crops on southern, southwest, and western slopes (Repolusk 1998a). Fertile eutric cambisol developed on flysch. The natural vegetation is deciduous forest as well as various types of evergreen shrubs that primarily grow on sunny slopes less suitable for farming. In order to acquire more arable land, maintain soil moisture, and limit erosion of the fertile soil, people probably started terracing the area's steep slopes already in Antiquity (Gaspari 1998).

Settlement, architectural, and archeological heritage units in the Krkavče area have been listed in the Slovenian register of immovable cultural heritage (Register … 2016). These include the village core, the hamlets of Hrib, Rov, Škrljevec, and Žvabi (in addition to these, the village also includes the hamlets of Abrami, Draga, Glavini, Griči, Mačkujek, Pučarji, and Sv. Maver), Saint Michael's Church, and the Sveti Štefan archaeological site, which are protected as cultural monuments of local importance. For this area, the register of natural points of interest lists ecosystem and arboreal features, and the Dragonja River was proclaimed a natural monument of national importance by the Ordinance Designating Individual Natural Monuments and Horticultural Monuments in the Municipality of Piran (1990). The entire territory of Krkavče is part of a Natura 2000 site and, as part of the Dragonja catchment area, is also included among Slovenia's ecologically important areas (Naravovarstveni atlas … 2015).

The Registry of Immovable Cultural Heritage also includes terraces; however, not explicitly on the village land of Krkavče, but in the areas of the neighboring villages of Sveti Peter to the west and Puče to the east. The Puče entry (under registration number 15090) explicitly states that the cultivated terraces between Krkavče Creek and Supot Creek are a protected area. The preserved traditional system of cultivated terraces arose at the transition from the plateau-like flat ridges into the steep slopes above the Dragonja Valley. The neighboring villages of Krkavče and Koštabona are mentioned in particular as settlements that dominate the broader surroundings of Puče. Moreover, the entry under registration number 28602 directs attention to the nearby cultural landscape between the villages of Sveti

◀ The terraced vineyards of the Gorica Hills constitute Slovenia's most distinct terraced landscape in terms of the share of terraced land. MATEVŽ LENARČIČ

Peter, Padna, and Nova Vas. The area is defined as an area reshaped by man for agricultural use with cultivated terraces surrounded by walls made of local stone and protective woodland. Clustered settlements lie on the ridges above the valleys. Olive trees, grapevines, and garden vegetables are the predominant crops.

The wider region of Krkavče is characterized by centuries of continuous settlement as evidenced by archaeological finds, among which stands out the Krkavče stone (*Krkavčanski kamen*), which is still an enigma regarding its time of creation and its meaning. Written sources first mention Krkavče in 1064. The main part of Krkavče is the old clustered village core on a steep slope. In addition to the closely built-up core, the area – like the rest of the Koper Hills – is characterized by hamlets on the narrow tops of ridges and hills, which include groups of houses and individual buildings called *kažete* (Pucer 2007).

Pucer (2007) states that 547 people lived in Krkavče in 1852. Despite interim declines, the population increased until 1948. Before the Second World War, agriculture and animal husbandry represented the main activities of the locals. Products such as oil, wine, milk, bread, vegetables, and cherries were sold in Trieste and other coastal cities. Selling firewood was an additional source of income, and women also worked as washerwomen for Trieste families (Pucer 2007; Titl 1965). After the war, the locals found work en masse in coastal cities. After 1954, when Zone B of the Free Territory of Trieste was awarded to Yugoslavia, a large-scale exodus took place, which led to a decline in the population. However, the population has begun increasing in recent years mainly due to owners of vacation houses. The population reached 304 in 2015, which is still less than half of the 676 recorded 1948, the demographic peak. Modernization of the village has undoubtedly helped stop emigration: the road was asphalted in 1972, water mains were installed in 1985, and telephone lines were installed in 1989 (Pucer 2007).

According to data obtained from digital orthophotos, LIDAR images, and an on-site visit, more than a third (231.3 ha or 35.9%) of the land in Krkavče is terraced. In steep areas agriculture is only possible with terracing, but in recent decades the terraces have primarily been maintained where mechanized cultivation is possible (Brec 2014; Lisjak 2014; Trampuš

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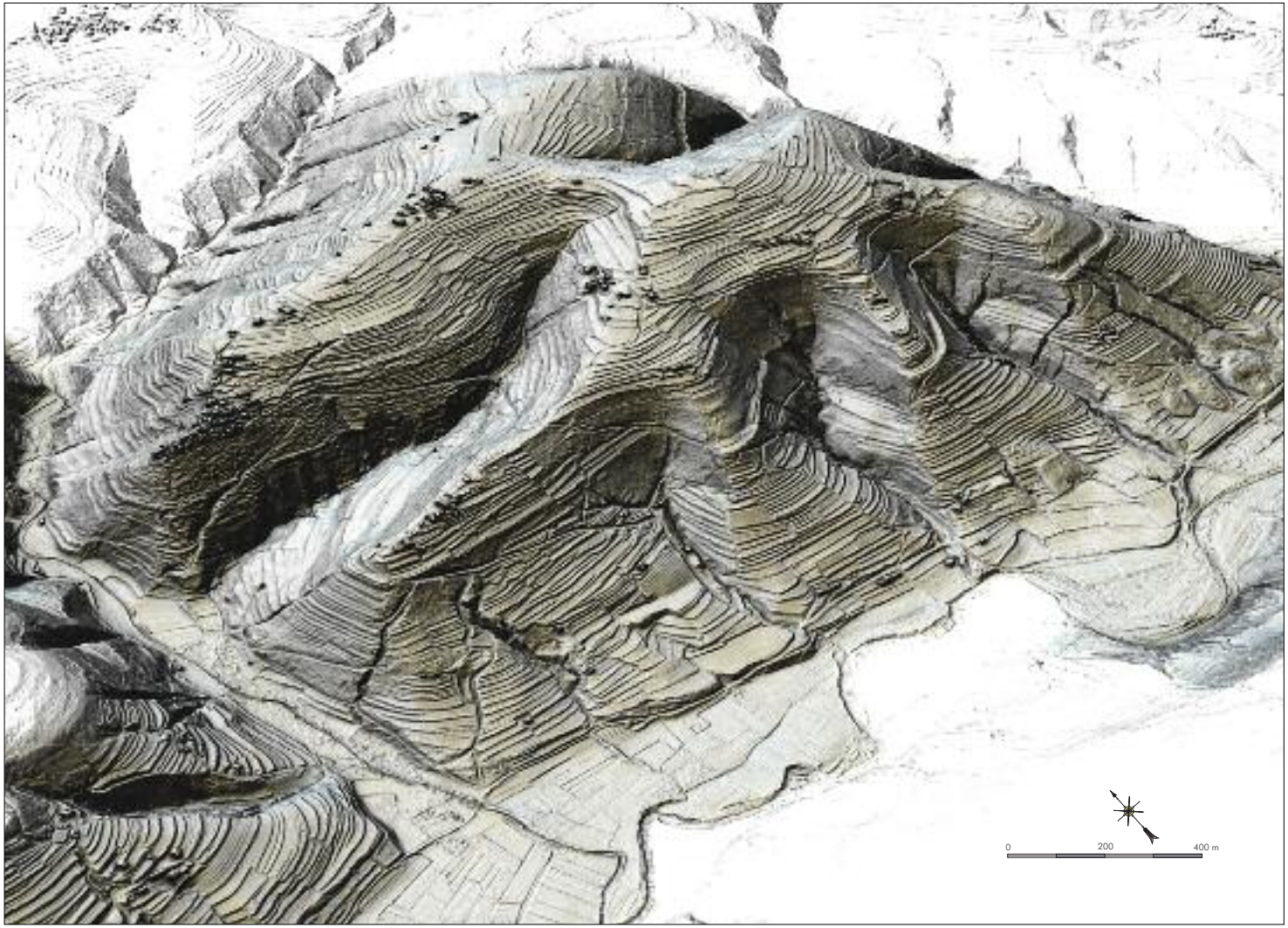
A panoramic view of Krkavče with the hamlet of Sveti Maver in the foreground, seen from the southwest.

2014). LIDAR images show that the land in Krkavče is terraced to an exceptional degree because terraces occupy nearly all of the sloped surface. Those on the most unfavorable slopes – that is, northern and steep slopes – already underwent afforestation in the recent past. The LIDAR image still shows terraces around the village core, but the quality of the data does not allow them to be distinguished individually. Newer terraced slopes can be distinguished by the regular and more coordinated shape of terraces.

When the Franciscan cadaster was created in 1819, the terraces were dominated by vineyards and there were not so many olive groves.



A LIDAR image of the area around Krkavče.

Titl (1965) states that winegrowing was more widespread and profitable in the past because the introduction of gas lighting in Trieste reduced the need for lamp oil. He suggests that Istrian cooking oil manufactured using simple equipment could not compare to Italian and French oils in quality, which explains why it sold poorly. At the beginning of the twentieth century, grapevines were severely affected by various diseases, but the vineyards were later restored in increased volume, which resulted in surpluses of wine, and so farmers began abandoning or replacing them with orchards (where olive trees also grew) and fields. During the interwar period, the volume of fields significantly increased at the expense of vineyards and orchards because growing potatoes and tomatoes proved profitable (Titl 1965).

In recent decades, the quality of olive oil has improved and olive oil is also more profitable than wine today. As a result, the ratio between olive groves and vineyards has almost reversed (Tavčar 2014). Lisjak (2014) states that olive trees, grapevines, and fruit trees, mainly jujubes and figs with a root system »binding the terrace« are cultivated on the Krkavče terraces nowadays. The terraces near the houses are commonly covered with vegetable gardens, which are generally fenced and protected from wildlife. According to the data on land use for Slovenia (2015), the terraces are dominated by olive groves (30.7%), whereas there are only a few vineyards (6.8%). There are also meadows and pastures (9.5%), and tilled fields (8.2%). In addition, 3.3% of terraced land is built up, almost as much is uncultivated, and orchards account for just over 1%. A full 27.3% of the terraced village land is already overgrown with trees, and a further 9.7% is undergoing afforestation.

It is interesting to compare the use of terraced land by elevation. The majority of terraces (28.9%) are in an elevation range from 50 to 100 m and dominated by forest (27.4%), followed by olive groves (24.5%), meadows and pastures (12.3%), and plots undergoing afforestation (10.8%). Other crops, which include grapes, individually account for less than a tenth of terraced areas. Only slightly fewer terraces (21.4%) are above the core of the village in an elevation range between 200 and 250 m, where the land use is reversed: the dominant crop is olive trees (56.5%), followed by forest (16.3%) and fields (8.0%). Other land categories are only marginally represented. Almost one-fifth (18.3%) of all terraced land is in an elevation ranging from 100 to 150 m, where it is also dominated by forest (49.4%). There are significantly fewer (27.5%) olive groves, and a full 15.4% of local terraced land is being overgrown. A share of 11.3% of all terraced land is in the upper elevation range, from 250 to 300 m. This area is dominated by fields (26.3%), meadows and pastures (22.1%), and olive groves (19.4%). The smallest percentage of terraced land is in an elevation range from 0 to 50 m and from 150 to 200 m, with exactly 10.0% in each. The land use in the lowest elevation range is mixed; the prevailing vineyards (22.2%) are followed by fields (15.4%), forest (14.7%), meadows and pastures (14.3%), areas undergoing afforestation (13.1%), and olive groves (12.6%). The elevation zone from 150 to 200 m is dominated by forest (50.1%), while olive groves (30.4%) largely dominate the agricultural land.

Even though the locals try to at least basically maintain the terraces (Lisjak 2014), overgrowth is continuing. Today, the cultivated terraces remain mainly on the southern (25%) and southeast slopes (23%), dominated by olive groves (a total of 41.7% for both orientations). However, the share of overgrown land is the greatest here (47.2%), which indicates a further reduction of arable land. The terraces facing southwest (13%) have more forest (31.8%) than olive groves (27.6%), but there is less land undergoing afforestation (11.2%). An even greater proportion of forested area is on the terraces facing west (12.3% of such terraces), northwest (12.1%), east (6.8%), northeast (3.5%), and north (4.4%). This indicates that even the land that was less favorable for cultivation was largely terraced in the past. Nevertheless, a great proportion of this land is already overgrown with trees. Afforestation does prevent erosion, but it reduces landscape diversity and biodiversity, and leads to changes in habitat types. Regarding the inclination, the majority (43.4%) of terraced land is on slopes with a gradient ranging from 0 to 15.0%. Steeper slopes correspond to less terraced land. Less than one-tenth (7.5%) of the terraces are on slopes with a gradient over 70%. Lisjak (2014) states that terracing took place on slopes with a gradient of at least 5%, and the width of the terrace platform was dictated by both the terrain and the depth of the soil: the steeper the slope and less fertile the soil, the narrower the terrace. Terraces could be wider using modern technology, but the lack of soil remains problematic. The soil layer on the old terraces was usually 30 to 50 cm deep. Some terraces on gentler slopes are so wide that the owners have turned them into pastures.

According to the locals, the reduction of terraced land is a result of several factors: the abandonment of agriculture by younger generations due to unprofitability, contentious or unregulated ownership, the remoteness and challenging accessibility or inaccessibility of some terraces, and a lack of cooperation between institutions that leads to more bureaucracy, whose victims are mostly farmers that, instead of cultivating the land, lose time in acquiring and supplementing various applications and approvals (Lisjak 2014). The first to be abandoned are the terraces where olives, which are a very profitable crop, do not grow well (Lisjak 2014; Brec 2014). In Brec's opinion, this process is mainly taking place in the Dragonja Valley because the Dragonja as a protected area represents an important factor in limiting opportunities for use. If a need for new farmland appears, an abandoned terrace is rehabilitated. Otherwise new terraces are not being built in Krkavče.

A particular challenge in maintaining the terraces is leasing terraced land, which can lead to a change of use. The owners of neighboring plots, people with the status of farmers, and farm policyholders from across Slovenia are given precedence when leasing. If two equally qualified persons compete to rent a terrace, an auction is conducted (Vrhovnik 2016) and the key factor is the amount of the rent, and not the place of residence, for example. Because locals are not able to pay high rents, the tenants often come from elsewhere, which can lead to illegal construction and camper parking because they need a place to stay and keep their tools (Lisjak 2014; Trampuš 2014). Tavčar (2014) associates this phenomenon with an above-average share of state-owned land in this part of Slovenia, which is a result of the postwar emigration of the Italian population.

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Sleme with the hamlet of Hrib, below which lie terraces on both sides with olive trees and a few fields, bordered on the shady northern side by unbroken forest extending high upwards.

The main change in terrace management compared to the past is abandoning the maintenance of dry stone walls. Lisjak (2014) states that they were being kept up until about 1954, when families were still large and it was essential to cultivate every inch of land. Back then, the supporting dry stone walls were built for purely practical reasons because the construction went hand in hand with manually clearing and preparing the land. The clearing produced piles of stone. The fastest and easiest way to use these was to build a wall and steps that made it possible to go from one terrace to another. Unlike concrete walls, which are mainly found along paths, dry stone walls have dry and airy spaces between the stones, where some plants and animals make their homes, such as the common wall lizard (*Podarcis muralis*). The loss of these walls also means a loss of habitat, and therefore animal and plant species. Farmers should thus be provided with funding for maintaining and restoring at least some of the dry walls because the renovation represents an (excessively) great financial burden. Lisjak (2014) suggested the renovation of dry stone walls along the gravel road leading from Krkavče to the hamlet of Sveti Maver because the footpaths could be included among tourist attractions.

In recent decades, dry stone walls have been replaced with earthen terrace slopes (Lisjak 2014). In Istria, a terrace slope is called a *korona* »curve«, and a terrace platform is called a *njiva* »field« or *leha* »bed«. In Krkavče, the terrace slopes are mainly overgrown with grass, not fruit trees or other crops, as Titl (1965) stated in the mid-1960s with regard to the terraces in the countryside around Koper. However, growing fruit trees and other crops could definitely increase the profitability of land in the areas with difficult cultivation conditions. Brec (2014) suggests planting them with lavender to use for manufacturing creams and soaps. On the other hand, terrace platforms below olive trees are not planted because of mechanized cultivation.

In some areas, farmers are eligible to receive subsidies for agricultural activities with natural or other limitations. New investments – for example, establishing a new olive grove – allow farmers to apply for funds offered by the Ministry of Agriculture, Forestry, and Food through public tenders.

The cultivated terraces in Krkavče, especially those with dry stone walls, provide numerous ecosystem-related services such as supplying food, preventing water and wind erosion, preserving soil moisture and biodiversity, and ensuring abiotic heterogeneity. Their special structure undoubtedly affects the attractiveness of the landscape. For all of these reasons, it is necessary to preserve the Krkavče terraced landscape otherwise it will largely become subject to afforestation.

MIHA PAVŠEK

Mechanical renovation of terraces (the photo shows an example from September 2015) makes it possible to work with steeper earthen terrace slopes.

The sample area for the **Mediterranean plateaus** is the village of **Merče** (391 m), a small clustered settlement in the southeast part of the Karst region, also known as the Trieste–Komen Plateau, in the immediate vicinity of Sežana. The village developed next to a lowland that has always been important for the transport network. The old road connecting Trieste and Divača as well as the parallel Austrian Southern Railway built after 1850 pass through this area. In addition, the freeway section between Divača and Fernetti runs not far away from here.

The nearly 4 km^2 area occupied by the village dates back to the Cretaceous period according to lithostratigraphic studies (Jurkovšek et al. 1996, 2013). The rock layers have a Dinaric northwest-southeast orientation. Carbonate rock predominates: the dolomite breccia zone in the north that runs along the Divača Fault and lowland is followed by dolomite to the south and limestone in the southernmost part. The karst terrain features become more apparent in this direction. The most karstified southern third of the village territory is riddled by many sinkholes several meters deep and also the Dol Lipovnik collapse doline on the western border, which is over 50 m deep. To the south, there are several formerly connected caves – Perko Cave (*Perkova pečina*), the Bestažovca Shaft, Sirk Cave (*Sirkova jama*), and Tavčar Cave (*Tavčarjeva jama*) – whose dry passages are about 450 m above the current active caves (Mihevc 2013). Impermeable components, primarily chert, can be found in some places.

The village area has no surface water streams, but Štirnca Spring, which has always just barely satisfied the inhabitants' water demand, had a permanent water source on the northwest slope of Prnji Hill (*Prnji hrib*) until the late nineteenth century. The source was presumably connected with the neighboring water-rich Planina Hill via a siphon tunnel. The creek flowed towards the north into the central basin below the village. During the earthquake that struck Ljubljana in 1895, the creek dried up, leaving a reminder in a preserved gap at an elevation of 421 m and a walled basin underneath. Even before that, the locals built a branch of the railway water distribution system between Padež, Sežana, and Trieste,

constructed in 1857, to supply their livestock (Mohorič 1968; Čehovin 1968). After the spring dried up, they became completely dependent on rainwater. The village has six cisterns, which are still in use. In 1898, they built a larger water tank with a capacity of 300 m³ that collects water from Ščenetnik Hill. In the 1920s, they walled the village pond where the water from Planina and Gabrovec hills is collected and filtered into the lower watering hole for livestock. For some time now, the Brestovica water distribution system, built in 1984, provides water for the wider region (Škrinjar 2015).

Merče has a submediterranean climate or, according to Ogrin (1996), a modified or hinterland submediterranean climate. The winters are relatively cold (2.4 °C), and the summers less hot than by the sea (20.8 °C). There is also more precipitation (nearby Komen annually receives 1,645 mm), which is better distributed throughout the year than in the neighboring area, thus creating favorable conditions for growing crops. The coast of the Gulf of Trieste is only 12 km away. Winter temperatures are usually low, and the weather varies significantly despite the moderating influence of the sea. Warm thaws and the southern wind from the sea alternate with incursions of cold air from the continent. The »icy« bora wind is frequent; the danger of snowdrifts and sleet is common (Rejec Brancelj 1998; Mihevc 1998). Long vegetation and crop periods provide favorable conditions for growing grapes. Merče belongs to the Primorje or Karst winegrowing region (Vodopivec 1994), but the proximity of the Dinaric mountain barrier influences the area around the village, resulting in it being the extreme edge of the winegrowing area towards Slovenia's interior.

The settlement does not have a planned layout; the clustered core has been spreading outward towards the terraces, but is stagnating today. The village had its largest population, about 250 inhabitants, in the last two decades of the nineteenth century, and it experienced the greatest decline between the beginning of the First World War and the end of the Second World War, when the population dropped by more than a third. In 1948, 157 people lived in the village, and afterwards the number gradually declined. At the beginning of 2015, only 108 people were living in Merče. The age structure is relatively unfavorable, with only fourteen inhabitants below the age of fifteen and twenty inhabitants over the age of sixty-five (Slovenian Statistical Office 2015).

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A panoramic view of Merče from the west.

The elevation of the lowland to the north is about 360 m, but the bottoms of the local sinkholes are another 15 m lower. A contiguous area of terraces extends across this part. South of the road and the railway is the largest karst depression, with its bottom at 380 m. The majority of the village's homes are clustered on its eastern bank. All of the gentle slopes of the basin that were not built on are terraced. The terraces extend across Ščenetnik Hill towards the neighboring village of Plešivica to the southeast and continue on the steeper slopes of the hills surrounding the central depression. The prominence of the surrounding hills ranges from a few dozen to over 170 meters, and their absolute elevations range from 450 to 550 m. The highest hills are west of Merče bordering Sežana: Zidovnik Hill (572 m), Big Hill (*Velika planina*, 551 m), and Broad Peak (*Široki vrh*, 516 m).

A LIDAR image of the area around Merče.

All of the Merče terraces are concentrated at an elevation of 350 to 450 m. Over a third of them are below 400 m, and the rest are above it. Almost three-quarters of terraced land (73.8%) is on gentle slopes with a gradient up to 15.0%, a fifth (19.6%) on moderate slopes with a gradient of 15.1 to 30.0%, and only just over 6% are on steeper slopes. There are no terraces in the southern karstified half of the village territory due to the slope gradient, rock content, cavernosity, and associated dry soil. Less than one-third (30.0%) of terraced land has a sunny southern, southwest, or southeast orientation, and more (40.4%) is on the shady northern, northeast, or northwest slopes. At the same time, a significantly greater proportion faces east than west.

Terraces are concentrated in the northern half of the village because of favorable rock and soil composition, and smaller inclinations. The village's immediate surroundings, the lowland north of the road axis, and less steep land on the border with the neighboring village of Plešivica were terraced first. A lack of grazing land resulted in the gradual terracing of more remote and steeper land. Terraces were built by shepherds. Grubbing out stones and building walls was a useful way to spend the long hours out in the pastures, while also ensuring the continuation of their personal pastures. Excess rocks were deposited on the edges of the plots, thus creating piles of rocks and dry stone walls that mark the former division of the land.

Earthen terrace slopes are rare in Merče. In such cases, the embankment moves downward

with each ploughing. As a rule, the terrace belongs to the people living above it. However, the majority of terrace slopes in the Karst region are actually dry stone walls, which are most often from one half to 1 m high. The dry walls between the plots are higher than those between the terraces, and the highest (2 m tall) and sturdiest ones run along the main village roads leading to the former pastures. At that time, the neighboring fields and the harvest had to be protected from the intrusion of livestock.

The shape of the terraces is completely adapted to the landforms: the length and width of a hill, basin, sinkhole, or slope inclination. They might meander, their edges are not necessarily parallel, and sometimes the pattern narrows and at other times spreads out. The terraces for growing vegetables, field crops, and fruit trees were typically narrower than those intended for grain or for meadows and pastures. The length of terraces ranges from a few dozen meters up to 150 m, and their width reaches up to 30 m, rarely more. The longest terraces, measuring 300 m on the eastern foot of Ščenetnik Hill, reach a maximum of 15 to 20 m in width, whereas the ones on the steepest slopes, which stretch across the eastern part of Zidovnik Hill, the western part of Ščenetnik Hill, and the southern part of Hrib Hill, reach only 5 to 6 m in width. Certain vineyard terraces are even narrower. The most extensive and the most irregularly shaped terraces are found on the southeast side of the central basin, between Prnji and Ščenetnik hills. The terraced areas were named after their owners (e.g., *Kariževe njive* »Karič's fields«), location (e.g., *Nad Gabrovcem* »above Gabrovec home«, *Dolenji vrt* »lower garden«, *Nad brajdami* »above the vineyards«, *Nad Šircem* »above Širc's land«), or crops (*Brajde* »the vineyards«, *Lesana* »the wood«).

The most distant terraces on the top of the hills were only accessible to animals, whereas all of the terraces for farming, growing fruit, and mowing hay were accessible by carts and later by tractors. The main access roads run from the village in all directions and then branch off into steeper tracks leading to individual plots or terraces. The access paths branching off from one point of the track could have led to three terraces at different heights on the left and right sides each. Entering the terrace was possible through a gap in the wall, which was flanked by two massive upright stones embedded in the soil. The stones, which prevented damage to the wall if the wheels were stuck at its edges, were wider apart at the top, leaning into the wall. The dry walls are built extremely skillfully and contain a number of interesting details, such as stone steps for crossing the wall, or a special drain hole in the ground every few meters through which running water rinsed manure from the livestock path to the neighboring lower-lying tilled terraces. Usually, walnuts were planted below the opening because they grew very well under such conditions.

Therefore, the walls had multiple functions (Panjek 2015). The excess rocks that had been grubbed out on the parcel and not left in piles were put there, the walls safeguarded ownership by marking the area that belonged to a particular owner, and they were used for fencing the grazing land for livestock while also protecting the arable land, gardens, and orchards from them. The walls protected the soil from water and wind erosion, as well as plants from frost, wind, and drought. For this reason, grapevines were often planted next to the wall on its southern side to resist better the bora wind.

During the greatest use of farmland around 1900, terraced land in Merče occupied 52 ha or 13.3% of all settlement territory (LIDAR 2015). Otherwise, the Mediterranean plateaus have much less, only 3.56% terraced land on average. The Franciscan cadaster shows that the tilled terraces prevailed in Merče at the time, representing two-thirds. However, already then, forest covered one-sixth of terraced land, and vineyards extended across one-tenth of the land. Meadows and pastures covered just over 4%; a slightly smaller percentage was occupied by stone structures. Thirty years ago, grapevines and grains (wheat, spelt, oats, buckwheat, and barley) grew on the majority of terraced land; many of the terraces were also used to grow fruit trees (cherries, various plums, pears, medlars, figs, and mulberries), fodder crops, garden vegetables (potatoes, beets, carrots, peas, and beans), and rapeseed. In the first half of the 1980s, the purchase price of wheat was very high, thus promoting its sowing. Fruits and garden vegetables were also grown to be sold, especially in Trieste until the Paris Peace Treaties were signed after the Second World War. Today, wheat, potatoes, rapeseed, and subsistence vegetables are grown on the remaining arable land (1.6%). Twenty years ago, the village needed a combine harvester for two days, and today only for about an hour. Almost two-thirds of the terraced land is covered by meadows and pastures, and various types of grapevines or fruit trees grow in some places. Nowadays, there are also more orchards (1.8%) than vineyards (0.8%). Overgrowth is taking place on 3.7%

DRAGO KLADNIK

View of terraces with low stone slopes overgrown with bushes in the southwest part of the village territory.

of the terraced land, and a quarter (25.2%) has already undergone afforestation.
After Slovenia's independence and its accession to the European Union, agriculture declined sharply because it was not competitive. Currently, there are five mixed farms and about fifteen head of cattle in the village in comparison to approximately three hundred head only two hundred years ago. Today's shortage of manure results in farmers resorting to green manure by ploughing rapeseed into the soil. The inhabitants only maintain the terraces near their homes and they no longer build new walls in the traditional way. The walls are made by inserting steel mesh into concrete and covering it with rocks, thus creating the impression of a dry wall.

MAJA TOPOLE

A drainage opening in a dry wall, where water running along the trail for livestock used to rinse manure onto the lower-lying terrace level.

The locals are certainly not sufficiently aware that the terraces represent part of their cultural heritage that is, unfortunately, slowly disappearing. The causes of abandonment are diverse: the abandonment of agriculture, depopulation, good earnings in the non-agricultural sector immediately after independence, and ownership issues. First they abandoned the remote terraces on the steepest slopes of the hills, which were also the most difficult to access. They are now almost entirely overgrown by forest, mainly pine. The forest dates even further back on the terraced land that was under joint ownership before the Second World War. Afterwards, this common grazing land reverted to the state. Less inclined and remote terraces are also already being overgrown by shrubs, mostly hornbeam. The shrubs first start growing on the border wall, which is rapidly deteriorating, riddled with roots and covered with moss. The bushes initially only surround the terrace, but grow into trees in a few years, thus significantly impairing the insolation of the terrace and consequently its profitability. As a result, mowing is no longer carried out, and so shrubs and trees quickly cover the entire terrace. The terraced land covered with trees and shrubs is difficult to spot during the vegetation period; a bird's eye view is the easiest way to see and recognize it. The terraces stand out most clearly in late winter, when the trees are bare and the leaves have blown away.
Co-ownership also unfavorably affects the future of the terraces. Heirs are often unable to reach a unanimous decision regarding management, which is reflected in the abandonment of cultivation and maintenance, and the deterioration of dry stone walls. The difference between large terraces, which receive subsidies from European funds, and others is clear. The subsidies are small, covering only material costs and not the cost of labor. Only baling hay and selling it brings in some money. The owners mow only the terraces that are subsidized; narrow terraces, where maintenance presumably no longer makes sense, are subject to deterioration.
Only the few locals that are aware of the importance of terraces respect the effort of past generations. They never pass a stone that has dropped out of a dry stone wall without picking it up and returning it to where it belongs. One way to preserve the cultural landscape around the area and its experiential attractiveness is tourism. The village and the surrounding area offer a number of natural and cultural attractions that could be included in tourism activities. In addition to the terraced landscape, the region boasts karst landscape features (karst stone, caves, shafts, natural climbing walls, sinkholes, and collapse dolines), fascinating flora and fauna, important archaeological sites, St. Andrew's Church and St. Mary's Church, typical Karst villages with their clustered houses, shepherds' stone cottages, wells, village ponds, and watering holes. Reintroduction of the old terrace crops and revitalization of local cuisine is yet another option. Moreover, good transport connections are a favorable circumstance. However, drivers on the freeway and regional road will continue to speed past the area if no attractive and organized tourism activities based on local tradition are presented to them. Nonetheless, such an innovative approach requires appropriate knowledge.


DINARIC SLOVENIA

The Dinaric landscapes, which occupy the majority of southern Slovenia and spread over 5,706 km² or just over a quarter of the country's territory, are the northwest part of the Dinaric Mountains. They consist of plateaus covering 3,809 km², which account for two-thirds of their area, and lowlands that cover 1,897 km² or the remaining third (Kladnik 1998b; Perko 1998).

A total of 293,000 people inhabit the nineteen Dinaric mesoregions (Registrski popis 2011). The number of inhabitants gradually increased until the Second World War. Afterwards, the number decreased sharply and then began increasing again. The increase was slow until the 1970s, when it started gradually accelerating. The increased population is mainly concentrated in the lowlands and plains, whereas the plateaus have lost a full third of their population.

A total of 5,643 ha or 0.99% of the land is terraced in the Dinaric landscapes, which is below the Slovenian average. More terraces are located in the lowlands and plains (1.60%) than on the plateaus (0.69%).

The Dinaric landscapes are dominated by limestone, which forms more than half of the terrain, followed by dolomite, which accounts for a quarter, and clay and silt represent just under one-tenth. The only other noteworthy rock is flysch, at 6%. The composition is completely different with regard to the layout of the terraced land. A full fifth of is found on flysch, and just over a third on limestone. The karst terrain is less suitable for agriculture, which results in less agricultural land in this area and therefore fewer terraces. These prevail on the patches of non-carbonate rocks. A similar situation is reported elsewhere in Europe; for example, Ginés (1999) reports this for the Balearic island of Majorca. Just like agricultural terraces in the Mediterranean commonly appear on flysch, an above-average percentage of terraces in the Dinaric landscapes also appear in areas with a high proportion of flysch; for example, the Kambreško Hills and Banjšice Plateau (*Kambreško in Banjšice*) areas in the northwest (1.69%), the Pivka Valley System (*Pivško podolje*) in the central area (1.70 %), and in White Carniola (*Bela krajina*, 2.94%) and the Gorjanci Hills (*Gorjanci*, 2.23%) in the southeast. The terraces on carbonate rock occur mainly on chromic cambisols (eTla 2015) and more often on dolomite than limestone in terms of number.

Terraces lie up to an elevation of just over 700 m. The majority, almost a third, are at an elevation ranging from 300 to 400 m, followed by a fifth in the range from 200 to 300 m.

The proportion of terraces on steep slopes is below average. In the Dinaric landscapes, the terraces also predominantly lie on sunny slopes; nevertheless, this dominance is less pronounced than in the Alpine and Mediterranean landscapes.

The Dinaric landscapes are heavily dominated by the tilled terraces; however, fields only continue to occupy one-eighth of the area because they have largely been replaced by meadows and pastures. White Carniola, the Radulje Hills (*Raduljsko hribovje*), and the foot of the Gorjanci Hills have a more favorable climate that allows winegrowing, which has resulted in a considerable number of vineyard terraces. Like the ones in the Pannonian hills, these terraces were only created in the second half of the twentieth century. However, only 2% of the Dinaric terraces are covered by vineyards. A slightly higher percentage is used for orchards, which also include a few intensive fruit-growing areas.

Overgrowth is taking place on an exceptionally large proportion of the terraced land. A tenth has already undergone afforestation, and a further tenth is in one of the stages of overgrowth.

The inhabitants of karst regions had to fundamentally modify the land for cultivation. They had to grub out the rocks protruding from the ground and excavate the soil in karst hollows. They stacked the rocks they removed into stone walls or put them into the retaining walls that supported the terraces on the slopes. The rocks that were removed from the upper part of the field were placed under the soil along the retaining wall (Gams 2003). Only a small proportion of such terraces can be found in Slovenian Dinaric regions; for example, in the Lokovec on Banjšice Plateau. Some terraces on the flysch slopes of the Kambreško Hills also have a stone retaining wall; these terraces can be classified as the Istrian type (Križaj Smrdel 2010a). The Dinaric landscapes are otherwise dominated by the Lower Carniola (*Dolenjska*) type of terrace, which was built on gentle slopes and has broad horizontal or outward-inclined terrace platforms and grassy slopes of various heights.

The sample area for the **Dinaric landscapes** is the village of **Dečja vas** (346 m), a clustered settlement on the northeast outskirts of Dry Carniola (*Suha krajina*), southeast of the town of Trebnje, on the karstified plateau above the blind valley of subterranean Temenica River. The hamlet of Pungrt alongside the road to Šmaver is a part of the settlement (Hočevar 1995). Dečja vas is functionally dependent on Trebnje, which is an important employment and municipal center in the eastern Lower Carniola Valley System (*Dolenjsko podolje*). Nonetheless, in terms of landscape characteristics, the village belongs to eastern Dry Carniola, which has slightly less pronounced karst features and is more densely populated than the western part.

The village area is characterized by a mostly forested karst plateau with many sinkholes, interrupted by some of the largest karst dells, such as the nearby Dobrnič Uvala to the west and the Globodol karst polje to the south, which is the most sharply delimited large karst depression in Slovenia. The terrain of Dry Carniola primarily consists of permeable carbonate rocks, mainly Cretaceous and Jurassic limestone, and dolomites to a lesser extent. In its northern part, which includes Dečja vas and its surroundings, one also finds impermeable clay formed through weathering of limestone and dolomite (Gabrovec 1998b). To the north, towards the Lower Carniola Valley System, the landscape becomes increasingly fluviokarstic. In addition to corrosion, the local dolomite surface was transformed by river erosion and denudation. Due to the lower density of karst hollows, the area offers better opportunities for agriculture (Senegačnik 2012).

Dečja vas has a temperate continental climate with an average annual temperature of 8.0 °C (data for the meteorological station in Ambrus for the period from 1961 to 1990), and the average October rainfall is higher than the April average (Gabrovec 1998b). East of the village is the vantage point of Saint Anne's Hill (*Sveta Ana*, 407 m) with Zijalo Cliff below it. The cliff is 35 m high and stands at the end of a pocket valley above a spring feeding the Temenica River. The river rises to the surface here for the second time after it briefly flows below ground. Zijalo Cliff is protected as a natural monument because of its special hydrological and geomorphological features. In the village's surroundings are Roman graves and iron ore deposits. In the nineteenth century, iron ore was processed at the smelter in the nearby village of Dvor in the Krka Valley. Traces of its exploitation are visible on the LIDAR

◀ Terraced village land at Lopata in Dry Carniola with tilled terraces where the former fields have largely been replaced by meadows and pastures; the first signs of overgrowth are also visible. MATEVŽ LENARČIČ

image as a bumpy surface in the middle and upper-right part. The LIDAR image also shows many lime kilns, small circular structures, often at the bottom of sinkholes. Access to limestone is easier on the slopes of sinkholes, and lime kilns inside sinkholes were protected from the wind. Dečja vas is also known for Archangel Michael's Church, which was first mentioned in 1526 (Hočevar 1995).

In 2015, ninety-four people lived in Dečja vas. The sex ratio is balanced. The population has fluctuated significantly since the 1869 census, when the settlement had 112 inhabitants. The number reached its lowest point in 1981, with just eighty-three inhabitants. The highest number of 112 inhabitants was recorded again in 1931, in addition to the first census year. After the Second World War, the number of inhabitants exceeded one hundred only in 1961. The age structure is advantageous; the number of children up to age fifteen is almost twice the number of elderly people sixty-five and over (Slovenian Statistical Office 2015). The demographic character leads to the conclusion that the existence of the cultural landscape in Dečja vas is not endangered. This favorable demographic character is most likely attributable to the advantageous transport position of the village near Trebnje and the freeway from Ljubljana to Zagreb.

The terraced landscape in Dečja vas is one of the finest examples of terraced landscapes in Lower Carniola and the Dinaric plateaus in general. A total of 61 ha or 20.0% of the land is terraced in the village area. The terraces are typical representatives of the Lower Carniola (*Dolenjska*) type of terrace (Križaj Smrdel 2010a). These are old agricultural terraces (their construction probably dates back to the Middle Ages), created by manual plowing. Fields extend on variously long and relatively wide terrace platforms, mostly stretching across the entire slope following the contour lines.

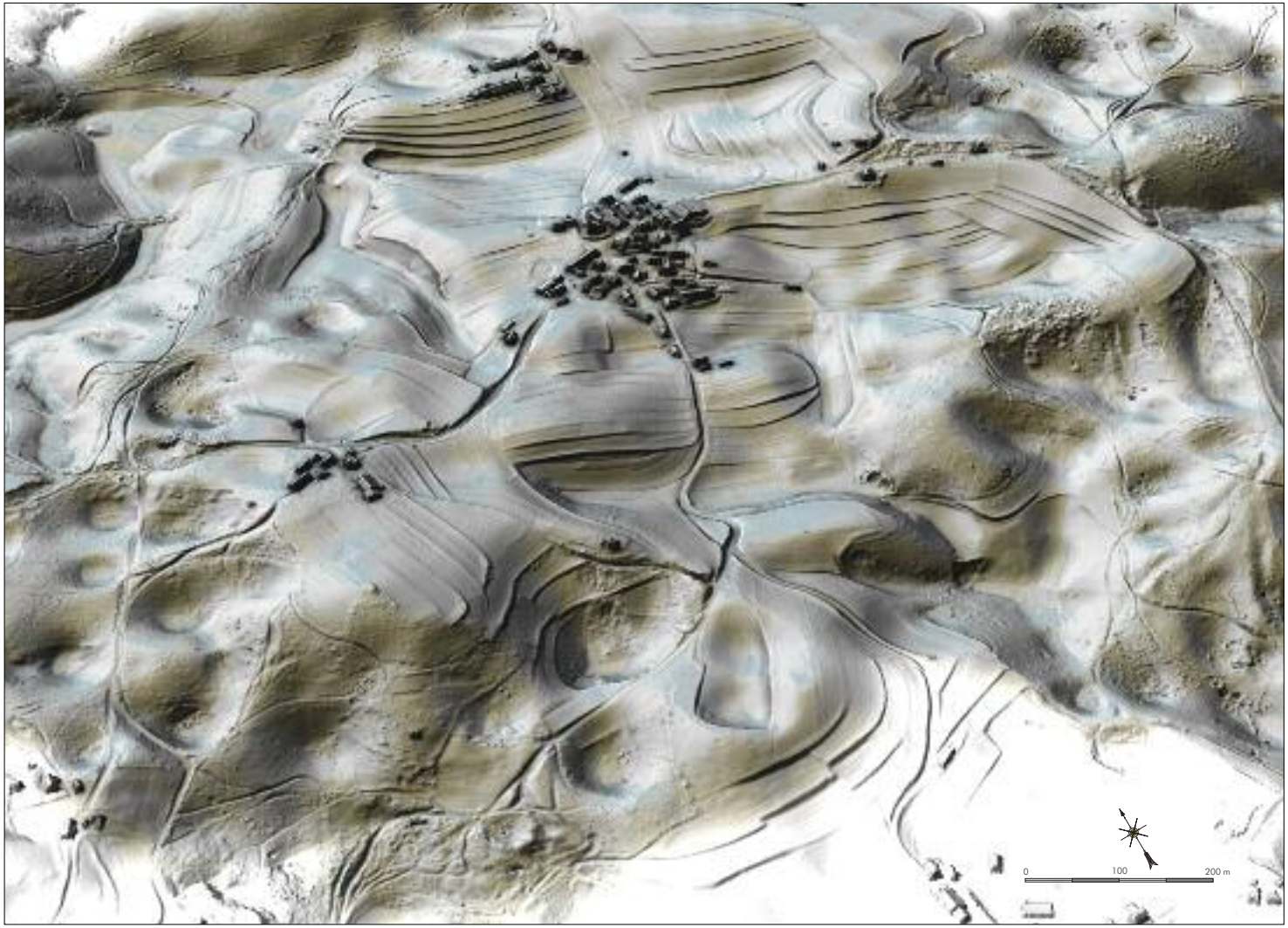
The largest and most prominent terrace areas resembling those of Dečja vas were the basis for defining the Lower Carniola terrace type. They can be found in the settlement of Šmihel pri Žužemberku in Dry Carniola, Dolenje Karteljevo in the Lower Carniola Valley System, the village of Petelinjek in the eastern part of the Novo Mesto region (*Novomeška pokrajina*), the area of Sodražica, the village of Velika Slevica near Velike Lašče, the Mirna Valley (*Mirnska dolina*), and the surroundings of Šentjanž. Although agricultural conditions on the Dinaric plateaus are not particularly favorable

MATEVŽ LENARČIČ

A panoramic view of Dečja vas from the west.

due to the relatively high elevation, harsh climate, predominant karst surface, and rugged terrain, a total of 2,616 ha of the land, or 0.7% of the area, is terraced. The entire area of the Dinaric plateaus is dominated by traditional tilled terraces, which are generally quite resilient landscape elements (Ažman Momirski and Kladnik 2009).

A unique feature of the Dečja vas terraces is the reddish-brown color of the soil, which was already mentioned by Melik (1959). This color makes the terraces particularly attractive outside the growing season or immediately after plowing, when the soil is most exposed. The terraces were created on Tertiary and Pleistocene clay on eutric cambisol (eTla 2015). The soil color strongly resembles the terra rossa found in the Mediterranean landscapes (e.g., the Karst region in Slovenia), but it differs in its chemical composition and physical properties; experts thus classify it among reddish-brown eutric cambisols. The typical color results from a high iron oxide content. The soil probably developed from insoluble dolomite residue. It is indigenous because it resists erosion due to its location on the top of the hill, and relict, because it was formed under different, warmer climate conditions (Gregorič 1969; Stepančič 1974; Urushibara 1976). A similar type of soil is found in other parts of Lower Carniola; for example, between Škofljica and Grosuplje, in the Dobrnič Uvala, and in the Šentvid Basin. Recent pedogenetic processes are enriching the soil with organic substances, which leads to gradual acidification (Stepančič 1974), and so farmers often apply agricultural lime to the soil (Gliha 2014).



A LIDAR image of the area around Dečja vas.

The terrace platforms are slightly inclined outwards and relatively broad. Their width (the average is estimated at 15 m) is largely dependent on the slope gradient. Terraced land closely surrounds the village on all sides and is highly adapted to the rugged terrain. The terraces extend over the entire traverse of the slopes; some of the terraces are thus up to 250 m long and create a unique terraced landscape. All terrace slopes are earthen and planted with grass. The height of the slopes varies significantly depending on the slope gradient and the width of the platforms. Most of them are about a meter high, over 2 m in exceptional cases, and quite steep, generally over 100%, or 45°. Farmers manually constructed these terraces by plowing, most likely during the initial colonization. As a result, they moderated the slopes, preserved soil moisture, and

prepared agricultural land that was originally intended for subsistence farming (Križaj Smrdel 2010a).

Locals call terrace slopes *meje* »borders« and the platforms *njive* »fields«. They are familiar with the term *terasa* »terrace« but do not use it in everyday life (Gliha 2014; Strajnar 2014). The agricultural terraces in Dečja vas also have their own microtoponyms, which are still used by the locals. The names most often reflect the characteristics of their micro-location; for example, *V dulah* »in the dell«, *Pri češnjicah* »by the cherry trees«, *V dolini* »in the valley«, and other names: *Ščebnice*, *Povoščinca*, *Poselek* (Gliha 2014; Strajnar 2014).

All of the terraced land in Dečja vas is at an elevation ranging from 300 to 400 m. Slightly over two-thirds of it is in an elevation range from 300 to 350 m. Considerably over half (58.4%) of the village's terraced land is on gentle slopes with a gradient of 15.0%, one-third (33.5%) on moderate slopes with an inclination of 15.1 to 30.0%, and less than one-tenth (8.1%) on steeper slopes. Interestingly, no particular terrace aspect markedly predominates in Dečja vas. The smallest proportion, 8.7% of terraced land, has a western orientation, and the largest, 15.0%, has a southwest orientation. Nevertheless, sunny terraced slopes slightly outweigh shady ones; 41.1% of the terraced land is on slopes oriented to the south, southwest, and southeast, and 37.4% is on slopes oriented to the north, northeast, and northwest. The difference between eastern and western orientations is also only slight. Equal representation of aspects is certainly the result of the gently inclined hillsides, which allow intensive farming in slightly less sunny locations.

The cultivated terraces of Dečja vas are also characterized by a dominant share of fields because they still occupy more than half (51.0%) of all terraced land. This is a special feature not only among terraced landscapes, but also among agricultural landscapes on the Dinaric plateaus in general, and even more so among other types of landscapes because most of the fields have now been replaced by meadows, pastures, and orchards because of less favorable natural conditions for agriculture, conversion to livestock farming, and the reduced importance of self-sufficient agriculture. However, greening – that is, an increased proportion of meadows and pastures at the expense of arable land – is also taking place in Dečja vas. Meadows and pastures already occupy 40.7% of the terraced land, which is almost a third more than about two hundred years ago. The proportion of other land categories is insignificant because it does not exceed five percent. In terms of preserving the cultural landscape, it is encouraging that, since the Franciscan cadaster was compiled in 1820s, the area of terraced land has remained virtually unchanged and the percentage of agricultural land undergoing afforestation remains insignificant (0.8%) for now. Primarily individual smaller sections of terrace slopes are being overgrown with trees and bushes, and about one-twentieth (4.9%) of the terraced land has already undergone afforestation. According to the local people, almost half of the terrace slopes were overgrown with bushes thirty years ago, but they were later removed and the slopes are being regularly maintained through mowing today (Gliha 2014).

It is surprising and alarming that the owners with whom we conducted in-depth interviews perceive the Dečja vas terraces only as cultivation land without any added value and beauty. Therefore, they are neither attached to nor proud of the terraces; moreover, they would prefer not to have them. They do not consider the terraces to be a special feature that could be included among the local tourism activities and presented in detail to visitors. The most plausible main reason for this is that the locals perceive the cultural landscape differently, and they are still dependent on it for their incomes and livelihood. Terrace agriculture is regarded as additional, time-consuming, cumbersome, unnecessary, and hard work that they derive no benefit from, only additional costs (Gliha 2014; Strajnar 2014). This is understandable to some extent: the rugged terrain, high terrace slopes, and unevenly wide, sometimes quite narrow, terrace platforms make today's mechanized cultivation difficult, and the platforms have to be mowed manually in several places. The farmers thus often consider simply smoothing out the terrace slopes where possible (Gliha 2014; Strajnar 2014). For this reason, it would be reasonable to introduce additional subsidies for cultivating agricultural terraces (farmers currently only receive subsidies for cultivating karst terrain that is classified as a landscape with difficult natural conditions), which would likely have a positive effect on the owners' attitudes regarding the terraces and thus their willingness to cultivate and maintain them in the future. The owners' positive attitude would then be passed on to their descendants, who only rarely decide to become farmers. However, the farmers estimate that contemporary agricultural activities are more intense than three decades ago because they are using more fertilizers and mowing more

DRAGO KLADNIK

A special feature of the terraces in Dečja vas is their reddish-brown loamy soil.

frequently. In the past, mowing took place only twice a year, which has increased to four or five times a year nowadays (Gliha 2014).
Cultivated terraces are also ecologically important because they preserve soil moisture and prevent soil erosion. Nonetheless, farmers report soil erosion and creep, which has been further exacerbated with the greater use of heavy agricultural mechanization. Hence the borders between the plots are changing and have to be constantly corrected depending on the actual situation on the terrain. According to Gliha (2014), an estimated 20 cm shift occurs in a period of thirty to forty years.
Some farmers make their living by selling the harvest and like to joke that in the nearby settlement of Mirna they sometimes manage to sell their white potatoes as red ones because the tubers are covered with reddish soil. The farmers unintentionally reveal where they come from because of the reddish-brown soil on their tractor tires (Strajnar 2014).
Because of their characteristics, among which dominate the share of fields, the harmonious interplay of arable and grassland use, the reddish-brown loamy soil, and the rugged, rolling terrain, the Dečja vas terraces are one of the finest examples of agricultural terraces in the Dinaric landscape, an important landscape element, and, at least to the outside observer, a local landmark with great aesthetic, historical, and even spiritual value. Currently, the locals and most likely the majority of visitors lack awareness of what the area has to offer.

DRAGO KLADNIK

The terrace slopes in Dečja vas vary in height and are earthen, steep, and grassed over.

The cause of these circumstances may also be the fact that the Dečja vas terraces have not (yet) been recognized as cultural heritage and are thus not visited by tourists, which is certainly a pity. On the other hand, they represent a great potential for development. Dečja vas is part of a popular recreational area between the village of Ponikve and the wine-growing region of Šmaver, which is especially attractive for cyclists. The Dečja vas terraces (and the tilled terraces generally) are a fascinating area that could attract passersby through guided tours, learning trails, and e-content. This approach would help locals connect and identify with the terraces, appreciate them (and thus their work) more, and, finally, also preserve the cultural landscape in its current form and extent in the future.
The reddish-brown loamy soil is a unique characteristic of the terraces. Therefore, it is not enough to strive only to maintain the entire area of the terraced land and existing terraces; it is also necessary to preserve the fields, at least in their current scope. Even though fields still dominate the arable land, they are being slowly, but steadily – albeit less markedly than elsewhere in Slovenia – replaced by meadows and pastures. The interplay of fields and meadows on the Dečja vas terraces is reflected in a unique landscape character that is certainly worth preserving for future generations.
The sample area for the **Dinaric valleys and corrosion plains** is the village of **Velika Slevica** (610 m), which is a clustered settlement in the central part of the Dinaric Velike Lašče region (*Velikolaščanska pokrajina*) (Senegačnik 1995), east of the Mišja Valley and southwest of Velike Lašče. An asphalt road runs from Velike Lašče to Mala Slevica and then to Sveti Gregor; at Mramor, a narrow road branches off and leads to Velika Slevica.
The local name for the area around Velika Slevica is the Kakave Hills, which transition into the Slemena Hills to the south. Sveti Gregor at elevation of 736 m is in the center of the Slemena Hills (Mihelič 1998). The Kakave and Slemena hills consist of mainly impermeable Permian and Lower Triassic rock, especially dolomite, but also quarz sandstone and conglomerate. The area is like an island of ridge-valley river relief amid karstic surroundings. There are typical narrow ravines and steep slopes that end in dome-like peaks and rounded ridges (Mihelič 1998). Velika Slevica has a continental climate with average temperatures ranging from 8 to 9 °C, and approximately 1,600 mm of rainfall per year; summers are moderately warm, and winters are cold. According to Ogrin (1996), this area is somewhere in between two subtypes of continental climate: the temperate continental climate typical of western and southern Slovenia prevails in the west, and the temperate continental climate typical of central Slovenia prevails in the east.
Velika Slevica is a nucleated village surrounded by farmland on the sunny slopes and by woods on the shady slopes. Even though the dense forest cover is not visible on the LIDAR image, the forested area is still easily recognized from its rougher terrain, which is a result of smaller point density and intentional point classification. In terms of location and terrain characteristics, Velika Slevica is a typical settlement for the sparsely populated and rugged terrain of the Kakave Hills, where the settlements are usually located in dominant exposed positions at the higher elevations of rounded and dome-like hills. The Slemena Hills are not as steep, and are therefore more suitable for cultivation; due to temperature inversion, they are also sunnier and not as foggy (Mihelič

1998). Velika Slevica has a good location, and it also has rich cultural heritage: there are two chapel shrines and a column shrine modeled on a plague column, and in the center of the village stand a stone table, a cistern, and a trough commemorating 1927, when water mains were installed in the village. Annunciation Church dates from the seventeenth century and was mentioned in Johann Weikhard von Valvasor's work from the same era. It has three gilded baroque altars and stands on the top of hill with a good view (Register … 2016).

Craftsmanship was important for the Velike Lašče area in the past. An important trade route connecting the continental north with the littoral south led through the area past Velika Slevica until the nineteenth century. Various economic and social influences interwove and thus strengthened Slovenians' ethnic identity and cultural awareness (Natek 1998b).

The wider area around Velika Slevica is known as the cradle of Slovenian culture. Many important literary figures were either born or worked in nearby settlements – writers such as Jože Javoršek, Fran Levstik, Josip Stritar, and Primož Trubar – and consequently Velike Lašče was nicknamed the »Slovenian Athens.« One of the landmarks is also mighty Turjak Castle, the House of Auersperg's family seat. The Auerspergs were one of the largest landowners in Carniola until the nineteenth century and one of the most powerful noble families in what is now Slovenia. Primož Trubar's house in the village of Rašica, and the linden tree and hayrack in the village of Dolnje Retje, where Fran Levstik wrote his story *Martin Krpan*, are among the cultural heritage sites in the area.

There were fifty-seven people living in Velika Slevica in 2015 (Slovenian Statistical Office 2015), a larger number of men (thirty-three) than women. The number of residents in 1869, when the first census was carried out, was 135, almost three times larger than in 2015. The number of residents almost halved after the Second World War, when the number decreased faster. Between 1953 and 1961, the population decreased from 104 to seventy-nine. It seems that depopulation has now stopped; the number of residents has not changed since 2002. The lowest number of inhabitants was noted in the 2011 census, when Velika Slevica had forty-eight residents. The age structure is relatively unfavorable in terms of maintaining the number of residents and cultural landscape because the number of inhabitants younger than fifteen and older

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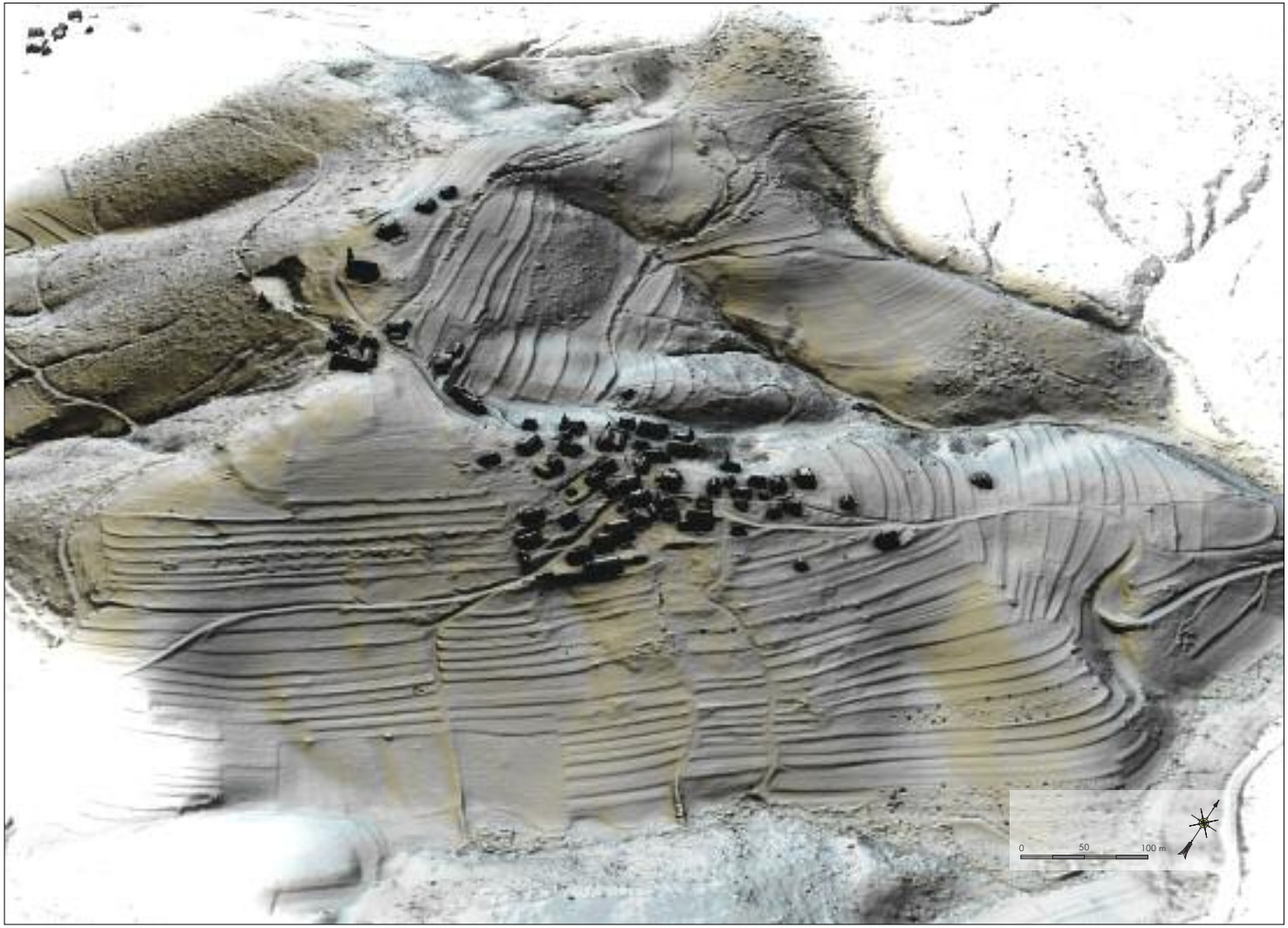
A panoramic view of Velika Slevica from the southwest.

than sixty-five is approximately the same (Slovenian Statistical Office 2015).

The Velika Slevica area is composed of Lower Triassic dolomite with layers of micaceous shale, on which a moderately deep layer of eutric cambisol with a high content of particles that retain soil moisture formed, which is therefore suitable for intensive agriculture (Mihelič 1998; eTla 2015). The majority of cultivated land is on relatively steep slopes that have also been transformed into terraces. They cover 27 ha or 23.9% of the settlement's territory. They represent the Lower Carniolan (*Dolenjska*) type of terraces (Križaj Smrdel 2010a), which are typical of the greater part of Lower Carniola. The origin of these old terraces is connected to agrarian partition into wide or irregular plots. Similar terraces can also be found elsewhere in the Dinaric area; for example, in Šmihel pri Žužemberku, Dečja vas in Dry Carniola (*Suha krajina*), Dolenje Karteljevo in the Lower Carniola Valley system, Petelinjek in the eastern part of the Novo Mesto region (*Novomeška pokrajina*), the Mirna Valley (*Mirnska dolina*), and the surroundings of Šentjanž.



A LIDAR image of the area around Velika Slevica.

Velika Slevica's terrace platforms have a rather noticeable outward tilt. Their width depends on how steep the slope is; the average width is approximately 10 m. The terraced area extends over the entire slope and there are only access roads crisscrossing it, creating an attractive terraced landscape. The terrace slopes are earthen and grassy, but in places they are already more or less overgrown with dense bushes. These slopes are mainly less than 1 m tall and have a 45° gradient. Their height depends on the slope's steepness and also the width of the terrace platforms. The tallest and steepest slopes are 2 m high. The terraces were created by plowing, most likely during the first colonization in the Early Middle Ages, when this area was settled. Farmers built the terraces to more easily work the slope and to improve the soil's moisture retention. They thus created agricultural land on gently inclined slopes that were intended only for subsistence farming up until the period of industrialization and abandonment of farming (Križaj Smrdel 2010a). The locals refer to a terrace slope as an *omejek* »baulk«, and the platform as a *njiva* »field«. They are, of course, familiar with the term *terasa* »terrace«, but they do not use it in everyday speech (Hočevar 2014; Stritar 2014).

In terms of elevation zones, over two-thirds (71.5%) of the terraced areas are in an elevation

zone from 550 to 600 m, less than a fifth (19.4%) are in the highest zone between 600 and 650 m, and less than a tenth (9.1%) are in the lowest zone between 500 and 550 m. The greatest share of terraced area around Velika Slevica – almost half (48.8%) – is located on moderately steep slopes with a 15.1 to 30% gradient, and more than a third (37.1%) lies on gentle slopes with up to a 15.0% gradient. It should be mentioned that 11.9% of the terraced land is located on slopes with a 30.1 to 50.0% gradient.

The aspect of most of the agricultural terraces in Velika Slevica corresponds to their sun exposure. Almost half of the terraced landscapes have a southeast aspect (43.1%), and more than a fourth (27.4%) have an eastern aspect. Around a tenth (10.5 and 8.9%) have a southern or northeast aspect. Sunny exposures greatly prevail over shady ones. Altogether 54.5% of the terraces have a southern, southeast, or southwest aspect, and only 17.3% have a northern, northeast, or northwest aspect. Even more distinct is the difference between an eastern (79.4%) and western (5.9%) aspect. These days, for terraces in Velika Slevica is characteristic grassing over, accompany fields changing into meadows. This is true not only of the Dinaric valleys and corrosion plains, but also the majority of Slovenia (Gabrovec and Kladnik 1997; Ažman Momirski and Gabrovec 2014). This has happened because subsistence farming is not as important as before, and farmers' focus has shifted to animal husbandry (Kladnik and Gabrovec 1998), for which in this cool Dinaric area with good moisture content there are much better conditions than for growing crops.

The Franciscan cadaster shows a distinct difference between land cultivation then and now. In the past, the fields in Velika Slevica covered as much as four-fifths (79.8%) of all terraced land, and today there are only a few left, barely 2.5%. The locals say that this change became even more marked over the past three decades (Hočevar 2014; Stritar 2014). However, the percentage of meadows and pastures significantly increased from the middle of the nineteenth century until today, from 17.9% to 85.4%. The percentage of orchards has also increased; these were almost nonexistent, and today they cover almost a tenth (9.5%) of the terraced landscape. Fruit trees are mainly planted on the narrowest terrace platforms, which are almost always on the steepest slopes and are not as suitable for fields. The orchards are consisted mainly of old traditional apple and plum trees. It is necessary to be careful when defining how much area they cover because their definition and thus their land category has changed over time (Gabrovec and Kladnik 1997).

Overgrown terraces in the Velika Slevica are still not widespread, even though the first signs of overgrowth have become noticeable on some terraces, especially along the road to Mala Slevica; mainly slopes are overgrown with bushes. The reason for this is a lack of motivation to farm and, consequently, also to preserve the cultural landscape. A lack of subsidies for farming and maintaining the terrace slopes is at least partly to blame. This work is challenging because of difficult access, narrow plots, and steep slopes. It is impossible to mow the steep slopes with a tractor, and so farmers need to mow the grass manually – or, these days, with a string trimmer – but this is increasingly difficult because of the lack of labor force and also a lack of time (Hočevar 2014). In recent years, livestock have grazed on some terraces, and, although they prevent overgrowth by walking and grazing on the terrace slopes, they also destroy and flatten the borders between the slopes and platforms (Stritar 2014). If this continues, it may cause more meadows to change into pastures, and eventually some terraces will disappear.

In the long term, land fragmentation is the greatest threat to the terraces in the Velika Slevica area. The plots are very small and, in terms of land ownership, also very scattered, which prevents economical and more intensive cultivation. One owner reported that he worked more than sixty different plots, some of them smaller than 0.1 ha (Stritar 2014), which made farming very time-consuming and expensive. The present situation is a consequence of the previous manner of inheritance, when, to respect the principle of fairness, descendants inherited parts of different-quality plots from different parts of the village (Stritar 2014). At the same time, farmers complain that, because of the tall and uneven terrace slopes and narrow plots, they have difficulties with mechanized farming. There is a relatively high chance of a tractor overturning, and in nearby settlements there have been several accidents with tragic outcomes (Hočevar 2014). Farmers also have difficulties due to disagreements with neighbors and a lack of cooperation; it is not easy for them to agree on mowing land they do not own, even though the owner no longer uses the land, and the mowed grass is of little value (Hočevar 2014). Even though people believe the terraces are beautiful or attractive, they mainly see them

IGOR MAHER

The former fields on terraces under the village of Velika Slevica have now almost entirely been replaced by meadows.

as a constant and unavoidable need to adapt, and additional, unnecessary work. However, this attitude has changed significantly. Many locals have complained about the changing plot boundaries because of under-plowing. Due to the highly terraced village territory, it is unlikely that something like this would happen today (Hočevar 2014). It seems that the locals do not really identify with the terraces and their appreciation for the terraces has diminished. However, they still believe the terraces have a significant role in the environment because they preserve soil moisture and prevent erosion (Hočevar 2014; Stritar 2014). The number of problems with erosion is significantly smaller because the former fields are almost completely overgrown with grass (Stritar 2014).

The locals still use characteristic microtoponyms for terraces that especially reflect the particular characteristics of their microlocation, such as *Na vlako* »on the skid trail«, *Pod hribom* »under the hill«, *Na devcu* »in the strip field«, and *V kotu* »in the corner«; their ownership, such as *Pri Vinkotu* »at Vinko's place«; or their settlement history; for example, *Purga* from German *Burg* »castle«, referring to a structure believed to have stood at the vantage point near Annunciation Church, which is also a potential archaeological site because of its topographic features (Hočevar 2014; Stritar 2014; Register … 2016).

The Velika Slevica terraces have aesthetic, pragmatic (easier orientation, better visibility), identification, historical, and spiritual value, but it is not certain that they will exist in the future. Their aesthetic value is jeopardized partly because of the neglect and the consequent overgrowth of the terrace slopes. This mars the appearance of the otherwise harmonious landscape. Fragmenting farmland and narrowing plots can cause this process for terrace platforms as well. This is why it would be wise to consider providing subsidies for terrace farming because the farmers face difficult natural conditions that cannot compare with those in flat areas.

The terraced landscape in Velika Slevica is one of the most beautiful in Lower Carniola and in the Dinaric areas in general. They have not been recognized as part of cultural heritage yet, even though they have cultural – and especially aesthetic and identification – value. Interestingly, there is already a lerning trail with signboards running through the village, part of the 15 km Velike Lašče circular cultural trail. However, the terraces are not even mentioned. This is unfortunate because they are an important landscape feature that should not be taken for granted, and are also a part of cultural heritage that attests to human resourcefulness, adaptability, and the ability to change the landscape in order to make a living. For these reasons, terraces should be promoted as a tourist attraction and included in the learning lessons. This could result in the locals and the owners respecting them more and re-identifying with them. This would make it easier to preserve the terraced landscape in the Velika Slevica area for the benefit of future generations.

JERNEJ TIRAN

Indistinct terrace slopes may be most visible in winter, when the sun thaws the snow cover on them faster than on the less-inclined terrace platforms.

JERNEJ TIRAN

Terrace overgrowth, which begins with the uncontrolled spread of bushes on their slopes, is more of an exception than the rule for now.


ALPINE SLOVENIA

Alpine landscapes in the northern, central, and northwest part of Slovenia extend across 8,541 km², or over a good two-fifths of the country's area. They are divided into high mountain ranges (3,062 km²), hills (4,660 km²), and plains (819 km²). The northern edge is made up of the Julian Alps (*Julijske Alpe*) with Mount Triglav (2,864 m), the Karawanks (*Karavanke*) and Kamnik–Savinja Alps (*Kamniško-Savinjske Alpe*), and the Strojna, Kozjak, and Pohorje hills. In addition to these last three, there are also the Cerkno, Škofja Loka, Polhov Gradec, Rovte, Sava, Velenje, and Slovenske Konjice hills (*Cerkljansko, Škofjeloško, Polhograjsko, Rovtarsko, Posavsko, Velenjsko in Konjiško hribovje*). The mesoregion of the Ložnica and Hudinja hills (*Ložniško in Hudinjsko gričevje*) has a predominantly hilly character. The largest level expanses, the Sava and Savinja plains (*Savska in Savinjska ravan*), are part of the Ljubljana and Celje basins, respectively; they form connections with the Dinaric and Pannonian landscapes – the first one in the southern part, and the second one in the eastern part. The Alpine climate is characteristic of the high mountain ranges, and in the Soča Valley the influence of the Mediterranean can be felt, whereas a temperate continental climate prevails elsewhere (Ogrin 1996; Kladnik 1998a).

More than a million people live in Dinaric landscapes (Registrski popis 2011), or almost half of the Slovenian population. Since the first census in 1869, the number of people has been steadily growing. A distinct duality is noticeable between the economically rapidly developing flat and gentle inclined areas in the valleys and basins and the developmentally problematic remote and steep areas. Whereas a rapid increase in population has been characteristic of the Alpine plains (since 1869 their population has increased four and a half fold), the population growth in the hills and high mountain ranges has been far less intense (only 55 and 29%, respectively); after Slovenia's independence, there was even a slight population decrease in the high mountain regions, which is reflected in the large-scale depopulation of hilly areas.

In the Alpine landscapes, 7,765 ha or 0.91% of the land is terraced, which is the least among all of the main Slovenian landscape types and is a consequence of the less favorable natural conditions, as well as of the unique agricultural activity. Whereas the Alpine plains and especially the Alpine mountains have very little terraced land (0.38 and 0.21%, respectively), the Alpine hills are rather well »stocked« with terraces, with a full 1.46% of the land terraced, the most being in the mesoregions of the Cerkno, Škofja Loka, Polhov Gradec, and Rovte hills (*Cerkljansko, Škofjeloško, Polhograjsko in Rovtarsko hribovje*, 2.40%), and in the Sava Hills *Posavsko hribovje*, 1.68%). Terraces mainly lie on solid and clastic carbonate rock, as well as on metamorphic rock in the Pohorje Hills. They can be found as high as 1,200 m, but most are located in elevation zones between 300 and 800 m. Two-fifths of the terraced land is on steep slopes with a gradient ranging from 30.1 to 50.0%, and just slightly less on moderately steep slopes with a gradient between 15.1 and 30.0%. This is why terraces with relatively narrow platforms prevail. The steepest terraced slopes are in the hills. Due to harsh natural conditions they strongly prevail in sunny southern, southeastern, and southwestern exposures, where there are 58.2% altogether. It is interesting that the dominance of southern-facing exposures is particularly noticeable on plains that fall into the thermal zone where the most distinctly terraced southern foots of the slopes are located.

Tilled terraces prevail, where former fields (these now represent only 6.2% of terraced land) have been almost completely supplanted by meadows and pastures (78.8%). Orchards make up 4.2%, and vineyards represent only 1% at the eastern foot of the Pohorje Hills. Overgrowth is occurring on 3.2% of terraced land, and 4.8% has already undergone afforestation. Though Alpine landscapes do not fall among typical terraced landscapes, they still should not be completely overlooked. They are the heritage of ordinary people and their skill to adapt and develop survival strategies in demanding natural conditions, and a dynamic and unpredictable social and political environment. They reflect the ingenuity and perseverance of past generations, and in many places in the Sava and the Škofja Loka hills they are the chief cornerstone of the cultural landscape, which they irreplaceably aesthetically enrich with their contours.

The sample area for **Alpine mountains** is the village of **Rut** (671 m), a clustered settlement in a valley, the shape of which resembles a cirque, southwest of the cliffs of Mount Rodica (1,966 m), Mount Špickogel (1,942 m, a.k.a. Little Mount Raskovec, *Mali Raskovec*), New Peak (*Novi vrh*, 1,968 m, a.k.a. Big Mount Raskovec, *Veliki Raskovec*), Mount Hohkogel (1,938 m, a.k.a. Matajur Peak, *Matajurski vrh*), and their foothills, which descend to the bottom of the Bača Gorge (*Baška grapa*) to the south. Rut Creek (*Rutarski potok*, a.k.a. Rinžile) runs through the village and empties into Karspoh Creek lower down. Karspoh Creek then connects with Bad Creek (*Huda grapa*, a.k.a. Folsterpoh) and Žventar Creek (*Žventarska grapa*, a.k.a. Alpnpoh) to form Koritnica Creek (Lipušček 1995; Trošt 1968).

Rut has been connected to the bottom of the Bača Gorge, which is 7 km away, by a modern road only since 1971. Two years later the road was extended to Grant, a neighboring village 1.3 km away. Both settlements have always been closely connected. People from Rut and Grant used to marry each other and go to the same school in Rut, which operated until 1970 (Zgaga 1994). Rut is also supplied with water from Grant because the flow of the creek in Rut is too weak to be a reliable water supply (Kemperle 2015). With an area of 1,017.4 ha, Rut is the largest sample area, but it has the smallest proportion of terracing. Terraces only cover 43.8 ha or 4.3% of the settlement territory, which is still significantly greater than the Slovenian average. The creation of terraces in the Rut area is connected to the Tyrolean colonization of the wider area of the Bača Gorge in the thirteenth century.

Within the settlement area, slope rubble, partly consolidated into breccia, and unconsolidated moraine material prevail. The hillsides east and west of the settlement are composed of Cretaceous platy limestone and Triassic claystone, siltstone, and chert. The temperate continental climate of western and southern Slovenia is typical of Rut, with the average temperature in April lower than in October, a submediterranean precipitation regime, and substantial precipitation (Ogrin 1998). In the 1981–2010 observation period, the Rut meteorological station measured an average precipitation of 2,342 mm. The wettest month is November and the driest is February. Recently Rut averages snow cover for forty-three days, but in the period from 1961 to 1990 average snow cover period lasted for fifty-five days (Nadbath 2013).

As is the case in the entire Bača Gorge, emigration is characteristic of Rut because the

◀ Wide terrace platforms and steep earthen slopes of carefully cultivated agricultural terraces with a mix of fields and meadows at Razbor below Mount Lisca in the eastern Sava Hills. MATEVŽ LENARČIČ

population has fallen to almost one-eighth over the last century and half. The village had a predominantly elderly population of only forty-two residents in 2015. Both sexes are equally represented. At the time of the first census in 1869, 330 people lived in Rut but, unlike most other Slovenian localities, the population already started steadily declining at that time – only 287 residents remained by the beginning of the twentieth century. The largest decrease took place between 1961 and 1971, when the population fell by 44% from 167 to 116.

Rut is considered the hub of the former colonization area for Tyrolean immigrants in Tolmin area (Torkar 1996). In order to increase the profitability of his estate, Berthold of Andechs, the patriarch of Aquileia, populated the upper parts of the Bača Gorge with farmers from the areas surrounding Innichen (Italian *San Candido*) in the Puster Valley (Italian *Val Pusteria*, German *Pustertal*), who began to deforest the area (Kos 1948). For a long time the name *Rut* (also known as *Nemški Rut* »German Rut« since 1598) referred to the entire colonization area, which included thirteen villages: Rut, Grant, Stržišče, Kal, Trtnik, Obloke (mentioned as early as 1310), Bača pri Podbrdu, Kuk, and Znojile, and from the sixteenth century on also Hudajužna, Podbrdo, Petrovo Brdo, and Porezen (Torkar 1994, 1996). It enjoyed special self-government rights because it was organized as a *rihtarija*, an administrative unit that covered the area of the German colonization in the upper parts of the Bača Gorge and its side valleys. Its symbol was a sword with the year 1414, which is kept by the Tolmin Museum. The headquarters of the unit were located in Rut, and the local leader (known as a *rihtar*) also exercised judicial authority.

Until the arrival of the French in 1809, the area was exempt from some feudal duties (Torkar 1996). Self-governance was abolished in 1850, when the people of the Rut area were joined with a new municipality in Grahovo. Their last mayor and local judge was Simon Kos, who died in 1872 (Trošt 1968). In the process of entering the land of the entire former administrative unit into the land register, the name *Rut* was gradually applied to the central village. The process started in the eighteenth century and ended in the nineteenth century (Torkar 1994). Before that, the village of Rut was called *Koritnica*, and occasionally even *Nemška Koritnica* »German Koritnica«

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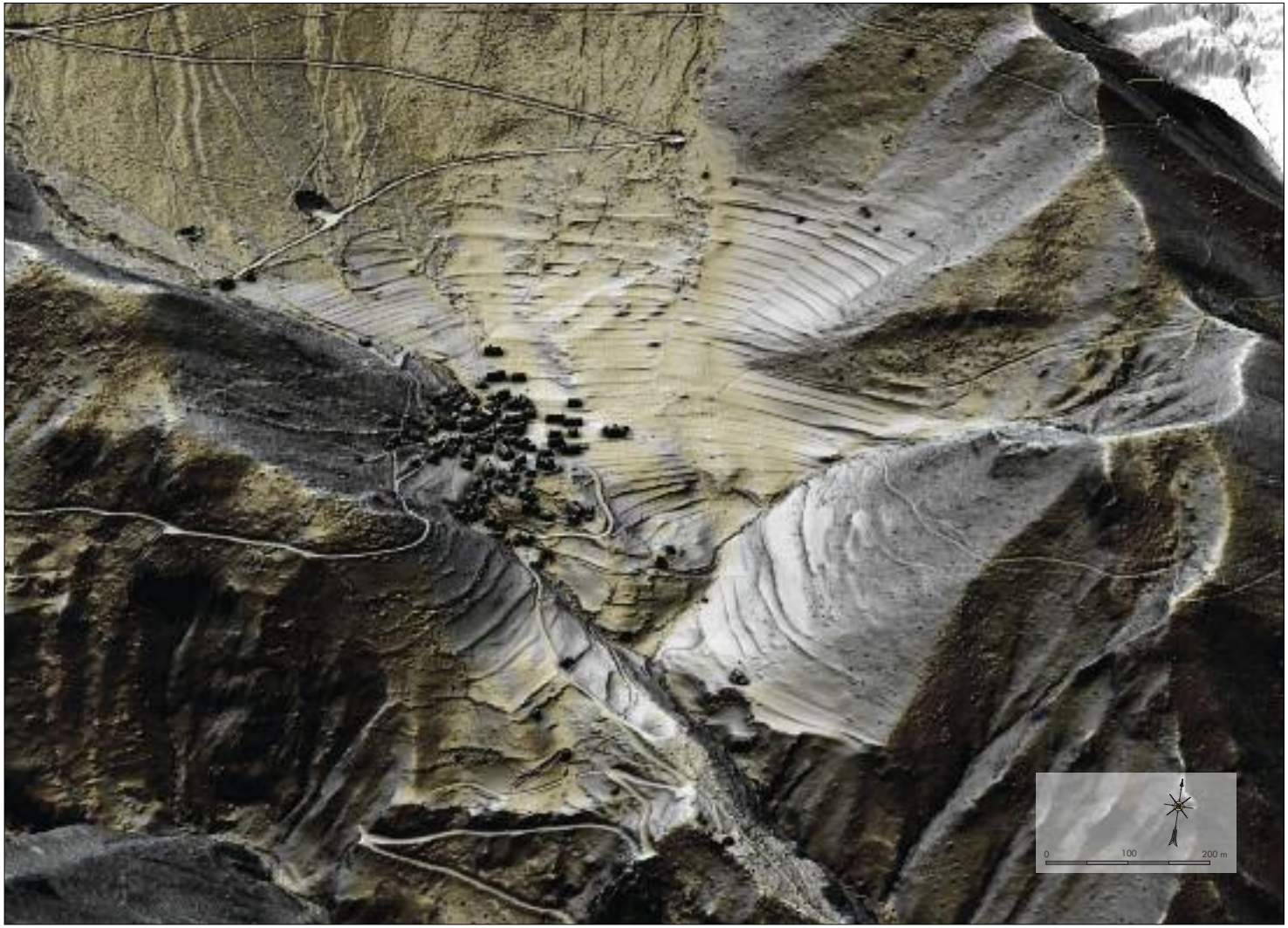
A panoramic view of Rut from the southeast.

(Torkar 1996). In the local dialect, the name *Koritnica* is still used for the village, mainly by the older residents of the neighboring villages such as Grant, Stražišče, and »Slovenian« Koritnica at the bottom of Bača Gorge. The two villages of Koritnica can be distinguished by their different locative prepositions in Slovenian: *v Koritnici* (with *v* »in«) means »in Rut«, but *na Koritnici* (with *na* »on«) refers to the village of Koritnica in the Bača Gorge (Kos 1948; Torkar 1994). The former municipality (*rihtarija*) and parish of Nemški Rut was a German linguistic enclave that was gradually Slovenized, even though the microtoponyms, hydronyms, and oronyms in the thirteen villages still strongly reflect the linguistic identity of the first settlers, who were of Tyrolean origin. Some villages were Slovenized relatively early on, except in the difficult-to-access center of the municipality, which had some self-governing autonomy and where old Tyrolean German was preserved up until the nineteenth century. After an interim period of bilingualism, Slovenian prevailed (Torkar 2006). Ties between Rut and Innichen still exist because delegations of both settlements still pay alternate visits to each other every few years (Koder 2015).



A LIDAR image of the area around Rut.

The parish in Rut was mentioned in historical sources as early as 1356. The local Gothic parish church of St. Lambert is the only church with chapels in the Tolmin area (Lipušček 1995; Trošt 1968). Next to it grows an ancient, hollow, but still quite vigorous linden tree with a terraced seat under the mighty crown. Here the *rihtar* used to settle disputes between the villagers. The 25 m high tree, with its 267 cm diameter and an 838 cm circumference, is one of the most prominent symbols of Rut and the entire Bača Gorge. Various sources, based on oral tradition, state that it is between five hundred and eight hundred years old. The linden tree is widely known as the symbol of village self-governance, which was given to people of the Rut area after their arrival from Tyrol. On December 15th, 1844, it almost burned down in a fire that destroyed the entire village, but it fully recovered later on (Trošt 1968; Lipušček 1995; Kozorog, Pagon and Fučka 2013). For over a decade now, the villagers have organized the Linden Tree Festival every last Saturday in June or the first Saturday in July (Kemperle 2015).

The terraces in Rut were created by the Tyrolean immigrants after they deforested the area, grubbed out the rocks, and stacked them into dry stone walls, which supported the land

where they created their fields. They appear on elevations between 580 and 830 m. The majority of the terraced land (34.1%) lies in an elevation zone between 700 and 750 m, a bit less (31.9%) between 650 m and 700 m, 20.3% between 600 and 650 m, and 12.6% between 750 and 800 m. Moderately steep terraced slopes prevail. Namely, the most terraced land is located on slopes with a 15.1 to 30.0% gradient (43.6%), and 27.4% can be found on steep slopes with a 30.1 to 50.0% gradient. Due to the relief and harsh climate, the majority of the terraced land has sunny southern exposures. A full 82.8% is oriented toward the southwest, south, or southeast, while the rest is oriented almost exclusively to the west or east.

In the 1820s, when the Franciscan cadaster was created, fields took up three-quarters (75.5%) of the terraced land, followed by meadows and pastures with just under a quarter (23.3%). In the modern age, the share of fields has fallen to a mere 1.4%, 5% of the terraced land is orchards, and the share of meadows and pastures has risen to over four-fifths (83.1%). Forest has overgrown one-twelfth (8.1%) of the terraced land, and 1.8% is undergoing afforestation.

There are three areas with agricultural terraces in Rut. The largest one spreads out to the north and east of the village core. Uniformly shaped terraces with elongated and inclined terrace platforms are characteristic of this part. The slope's gradient is smaller compared to the other two areas – for this reason the terraces are the widest here. The elderly locals simply refer to this area as *njive* »fields« because it used to be covered with fields. They ploughed them with draft animals and grew different kinds of grain. Now this area is exclusively home to meadows, which the farmers regularly mow. The stone slopes of the lower terraces are still well preserved, but on the higher-lying terraces the slopes are less distinct and made of earth. The ground above the terraces used to serve as upland meadows and pastures, but it was overgrown by forest or is being afforested today.

The second most extensive terraced area lies south of the village core and the road that connects Rut to Grant. On a steeper slope the terracing was scattered. This area was once covered exclusively with fields, but now none remain. Meadows with some small orchards prevail.

The third terraced area is located about 500 m west of the village core, on the steep slope of 874 m high Telečnik Hill, which the locals call *Grič* »Low Hill«, alongside the road to Grant. Only the terraces below the road are still partially preserved; the ones above it have already been overgrown by the forest and have disappeared because most of the dry stone walls disintegrated and the rocks that they were built of have tumbled down into the valley. Although this is the smallest terrace area, it has the strongest association with terraces for the locals. Unlike the other two areas, the land here was cultivated only by hand, without plowing. This terraced slope is steeper than the other two. Some large terraces measuring 10 by 10 m were attentively cultivated and they served as gardens. They were used to grow vegetables; for instance, kohlrabi, carrots, lettuce, beans, turnips, garlic, onions, parsley, and a few potatoes – basically, anything that did not require plowing. The gardens were located here because the area received a lot of sun or, as the informants stated (Kemperle 2015; Koder 2015), »there you had sun all day long.« This is why there was a smaller danger of a frost compared to other cultivated land. The terraces with garden crops were never watered because the rain took care of that.

The locals differentiated between two subtypes of terraces in this area. At the bottom were the seedling gardens (*flančnik*), where seeds were sprouted, and above these the vegetable gardens (*repnik*), where they would later transplant the seedlings. The locals also use these two terms to mark the terraces. Although they know the term *terasa* »terrace«, they do not use it in everyday life. To them terraces are therefore fields, seedling gardens, and vegetable gardens. Individual parts of the vegetable and seedling gardens were differentiated with microtoponyms, such as *Štuke*, *Grontik*, and so on (Kemperle 2015; Koder 2015).

It can be concluded from the stories of the informants that children were an important work force for cultivating the terraces, especially for the seedling and vegetable gardens on Grič Hill. Their main association with terraces is »hard farm work.« At the mention of the terraces on Grič, which no longer exist today, older locals first think of their youth and the intensive manual labor associated with cultivating the soil with a hoe. When they were not spending their time on the upland meadows, they were on the terraces in the vegetable and seedling gardens, where there was always work to be done, especially for small children – be it hoeing or weeding. In their youth they were also exposed to danger on the terraces: a stone or a rock from the dry stone walls could

JAKA ORTAR

Early spring at the top of the terraced village land seen from the path to Mount Rodica.

roll down onto the road, which connects Rut and Grant, and injure a passerby. This risk was especially high in the winter, particularly when there was a lot of snow and avalanches would be triggered, taking with them the rocks from the terrace slopes as well. Every time they would walk below those terraces they were on the lookout for falling rocks.

Water erosion leached the soil from the terraces into the ravine during the year, and so the people had to carry it in baskets up to the terraces again in the spring. In the case of heavy rainfall they had to repeat this process several times a year. Most of the time this was done by children as well. The work was very difficult because the slopes were steep and the load in the basket was very heavy. Every March and every April they also used the baskets to carry manure up to the terraces, which they used to fertilize the small fields. The work on the terraces was difficult, »but back then people were satisfied with everything and they never starved, at least they had something, better that than nothing.« Not only were the terraces beautiful because of the exemplary work done on them, but they were first and foremost indispensable for growing food (Kemperle 2015; Koder 2015).

The better memories of the terraces are mostly connected with meal breaks during work. The morning meal was called *frjajžen*, and the afternoon meal *kopček* (Kemperle 2015). Unlike Grant, where they stopped cultivating the vegetable and seedling gardens soon after the Second World War (Koder 2015), the last vegetable and seedling gardens in Rut were abandoned between 1970 and 1975. Namely, in 1970 the village school closed its doors, the children started to attend the primary school in Tolmin, and there was no more child labor available (Kemperle 2015). When the terraces were still being cultivated there were no fruit trees on them because they would have shaded the garden crops. Now that the gardens are gone, meadows occupy the lower remaining terraces, where there are apple and plum trees.

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A view of the same area from below, at the time of the first mowing in the second half of May.

The former terraced fields close to the settlement now serve as meadows, whereas the more remote former meadows and pastures on non-terraced land have been left to overgrowth. With this dynamic of land-use change, the forest will overgrow all of the village land, except for the meadows on the terraces, in a decade. With the exception of the fields, nature will take back everything that the Tyrolean settlers deforested for their farmland.

Why did the Tyrolians come to Rut and the Bača Gorge eight hundred years ago and why did they create terraces? Why did they maintain the dry stone walls for 750 years and carry soil up in baskets, which was washed into the ravine by water? The answers hide in the simple fact that their life here was still easier and better than it was in their original environment. Innichen, the hub of the Tyrolean immigration, lies at 1,175 m above sea level. The settlers did not come to the Bača Gorge from the central settlement in headwaters of the Drava River, but from some more remote villages in one of the neighboring valleys. Some of the villages were located as high as 1,400 m. In Rut, which has a fundamentally lower elevation and a distinctly southern exposure, the Tyrolean settlers could live considerably more easily than their ancestors before the migration, despite the efforts they put into cultivating the land and building and maintaining terraces.

The sample area for the **Alpine hills** is the village of **Smoleva** (580 m), a scattered settlement with a clustered core, 2 km south of the town of Železniki in the Selca Valley (*Selška dolina*), in the northern part of Škofja Loka Hills (*Škofjeloško hribovje*). The upper, clustered part of the village lies on a sunny ledge above the right bank of Lower Smoleva Creek (*Prednja Smoleva*), and the lower, smaller part lies at the bottom of the gorge of the creek, which empties into the Selca Sora River (*Selška Sora*) in the western part of Železniki, in the hamlet of Ovčja vas. To the east, Racovnik Kovač Peak (*Racmanski Kovaški vrh*, 882 m), Mowing Hill (*Seč*, 808 m), and Steep Hill (*Strmec*, 935 m) rise above the village, and to the west, on the left bank of the Lower Smoleva Creek, the forested slopes of Gorenji Konec Kovač Peak (*Gorenjski Kovaški vrh*, 862 m) and Vancovec Hill (1,085 m) overlook it (Savnik 1968; Šifrer 1996). Smoleva has been an independent settlement since 1953; before that it was part of Martinj vrh village (Šifrer 1996). Its inhabited part spreads out at an elevation between 500 and 760 m.

The partly karst landscape of village teritory is made up of claystone, siltstone, sandstone, and dolomite (Verbič 1998; Gabrovec and Hrvatin 1998). Despite an abundance of rainfall (the nearby Železniki precipitation station records between 1,800 and 2,000 mm every year; Mesečni bilten ARSO 2007), the rapid drainage of the water occasionally causes a lack of it in the soil. Smoleva has a temperate continental climate with a submediterranean precipitation regime, which is characterized by a primary rainfall peak in the fall and a secondary rainfall peak during the transition from spring to summer. The least rainfall occurs in

the second half of the winter. Due to the higher elevation, the average yearly temperature of around 9° C is somewhat lower than in nearby more densely populated flat areas (Ogrin 1996). The village core lies on the lower border of the thermal zone, which in the greater part of Škofja Loka Hills extends at the altitude from 600 to 800 m (Gabrovec 1998a).

Chromic cambisols developed on the dolomite surface and rendzina prevails on the steeper slopes due to stronger regolith leaching. Most of the surrounding area is covered with beech forest, where hop hornbeam, fir, and spruce can also often be found – the latter especially, because it was spread by people owing to its fast growth and the relatively high quality of its wood. The original forest was greatly thinned in the seventeenth century and the wood was mostly used to make charcoal for the ironworks in nearby Železniki. In the twentieth century, the thinned lands were reforested with spruce, which asserted itself as a monoculture in many areas (Gabrovec 1998a). The LIDAR image clearly shows a dense network of forest trails used for hauling wood that crisscross the slopes around the village core.

The entire Selca Valley was very sparsely populated until 973, when it came under the rule of the Bishop Abraham of Freising. The first colonization took place in the High Middle Ages from the tenth to thirteenth centuries, when Slovenians prevailed among the settlers. The colonization took place from the north and the east, but it only reached to the line represented by the villages of Podlonk, Škovine, Smoleva, and Ojstri vrh. The second wave, known as the Sarica colonization, in which a mostly German-speaking population from Tyrol and Carinthia settled the area, was characteristic of the western part of the Selca Valley and it did not reach Smoleva. From the fourteenth century onwards, many people from the Friuli region started coming to Železniki because of the ironworks. The increase in population also resulted in many cottagers settling on abandoned farms (Blaznik 1928; Ilešič 1938). When it was settled, Smoleva had four farms, and by the nineteenth century two more had been arisen. Even the residents of Smoleva had ties to the ironworks because iron ore was excavated in some parts of the settlement (Jelenc 2005).

Smoleva has always been a small village. From the 1869 census to the census in 1981, the population hovered between thirty and forty-five,

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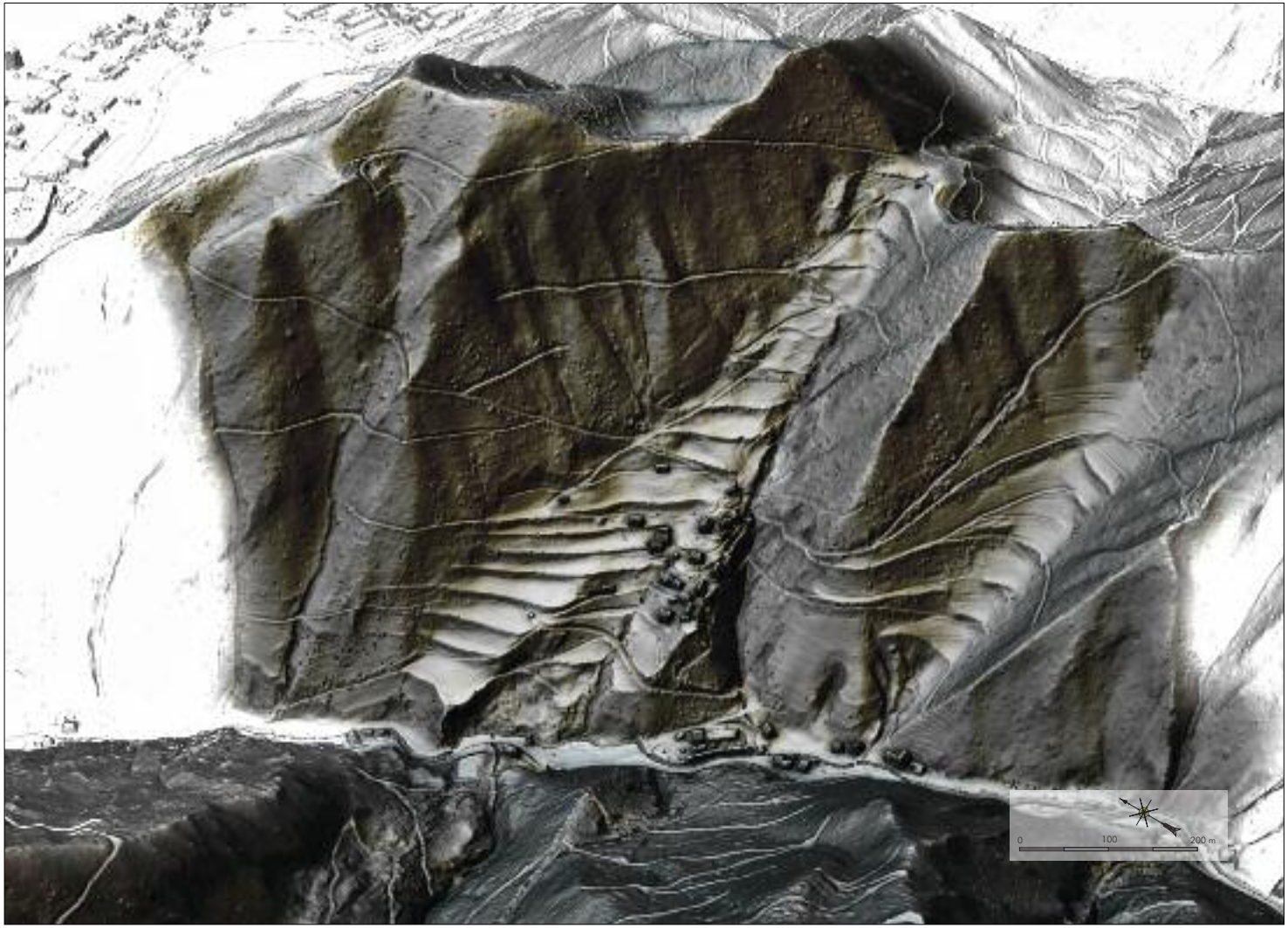
A panoramic view of Smoleva from the southwest.

but it has somewhat increased in recent years; fifty-seven people lived in sixteen households in mid-2015 (Slovenian Statistical Office 2015). The age structure is favorable because the children significantly outnumber the elderly, which is due to the high birth rates typical of the entire Selca Valley (Savnik 1968; census data; Šircelj 2006; Internet 3).

Since the creation of the village, the foundation for making a living was agriculture. When self-sustaining and subsistence farming prevailed, the majority of farmland was occupied by fields and meadows that were used to cultivate food for the people and fodder for the animals. Because the houses are located on the ledge of a distinctly steep slope, the fields were terraced, as they could only be cultivated in this way once plowing with horses became established. However, terracing was not only a way to expand the arable land and make its cultivation easier; it was also effective at decreasing soil erosion. An analysis of the orthophoto and LIDAR images showed that over 20 ha of land or 11.0% of the settlement territory is terraced in Smoleva. The terraces continue from the road in the valley to the upper part of the village and on the slope above it, whereas the second zone of terraced land lies on the slope across from Sušica Creek, south of the village core. A smaller complex of terraces north of the clustered part of the village is already completely overgrown with forest.



A LIDAR image of the area around Smoleva.

When the Franciscan cadaster was being prepared between 1818 and 1828, meadows (54%) and fields (40%) prevailed on the terraces. The fields were more common closer to the settlement. The orchards were only in the vicinity of the homes and the farm buildings. Forests and overgrowing land were almost non-existent, and the potential to utilize terraces to cultivate food and fodder was optimized. The entire second half of the nineteenth century was marked by the increasingly intensive use of farmland, followed by extensification. The farmers began leaving fields fallow in the first half of the twentieth century. The number of livestock decreased then as well (Ilešič 1938). According to statements by the Smoleva residents interviewed (F. Jelenc 2014; M. Jelenc 2014; O. Torkar 2014; R. Torkar 2014), the fields were maintained until the 1960s and 1970s, but they later significantly shrank due to the reduced significance of farming and increased employment in factories. In the past, terraces were used to grow

all of the crops that made subsistence farming possible: winter wheat, rye, barley, oats, buckwheat, potatoes, turnips, and other root crops (Ilešič 1938; F. Jelenc 2014; M. Jelenc 2014; O. Torkar 2014; R. Torkar 2014).

According to the Graphic Data of Land Use for All of Slovenia for 2015 (*Grafični podatki RABA TAL za celo Slovenijo* 2015), meadows and pastures (60%) prevail on the terraces today, mostly in the direct vicinity of the village core, on the slope above it, and on the terraced area south of Sušica Creek. Forest has already spread to one-third of the terraced land and has almost exclusively overgrown the isolated northern part of the terraces with an eastern exposure. Fields have only been preserved in the direct vicinity of homes, which suggests they are taking on the role of gardens. Compared to the past, some buildings have been erected on parts of the terraced land and fruit trees have expanded mostly on the terrace slopes and on the edges of the terrace platforms. The tree roots fortify the terraces and thus limit erosion. Land use already differed on individual terraces in the past because some of the fields were left fallow and then plowed after a year or two. The terrace platforms are flat or slightly outward-inclined whereas the quite steep and earthen terrace slopes are uniformly inclined and overgrown with grass, as well as with bushes and tree fruits in some places. The people of Smoleva regard the terrace slopes as meadows, and so they still mow them as they did in the past. Due to their steep gradient, they are very distinct, with a height of up to 8 m, and the terrace platforms are relatively narrow (Križaj Smrdel 2010a, 2010b).

The terraces in Smoleva are old, and the locals do not recall any new ones being built in recent decades or any being leveled. The slope is landslide-prone; the groundwater below the regolith causes it to creep. The locals refer to this with the word *usad* »slump«. They prevent it by driving wooden spikes into the terrace slopes or by planting fruit trees, mainly plums, cherries, pears, and apples. Because of this, the orchard land category has grown.

The terraces were created and maintained with a plowing-under technique, which was still in use only a few decades ago. The inner furrow was dug out and the material moved to the terrace's outer edge. By plowing towards the inside, the platform was constantly levelled out. The rocks that were grubbed out or plowed out were then piled up on the terrace's outer edge, on the slope, thus fortifying it. The heaps of stone were referred to as *groblja* »rock piles«; such piles can also often be found along the borders with the forest. The terrace platforms were plowed with horses, and all other chores were done by hand, including transporting stable manure. The terraces were manured by digging the manure into the ground, otherwise it would have been leached by surface runoff. There used to be no dirt roads, and the road that winds across the slope was created only a few decades ago. Nowadays, the mowing is done with tractors. Because there is no more under-plowing on the inner parts of the terrace platforms, they are becoming increasingly sloped toward the outside. The creep of regolith on the slope contributes to this as well.

The locals do not use the term *terasa* »terrace«. The common name for a terrace slope is *meja* »border«, and *njiva* »field« or *štapla* is used for a terrace platform. A complete terrace is called a *stopnica* »stair« or *štenga*, also »stair« (F. Jelenc 2014; M. Jelenc 2014; O. Torkar 2014; R. Torkar 2014). The area of the settlement where the buildings and the majority of the agricultural land are located is highly landslide-prone. Ground creep has caused the locals quite some trouble in the past, not only in preservation of farmland, but also by causing houses and farm buildings to collapse. The landslide-prone area is divided into a fossil landslide on the slope above the clustered part of the village and an active lower landslide between the Lower Smoleva Creek Gorge and the village core. Creep develops on a foundation of claystone, sandstone, and siltstone, which all weather quickly. After the Easter earthquake of 1998, the sliding became stronger, which was also detected after heavy rainfall in the fall of 2000 and spring of 2001 as well. The use of heavy construction machinery has also contributed to the terrain's instability because several older houses have been replaced by new ones in recent decades. The landslide rehabilitation came in two stages, in 2002 and 2011 (Lazar 2002; Jelenc 2005).

Almost all of the terraces lie at an elevation between 500 and 850 m, and three-fifths of the terraced land is located between 550 and 700 m. The orchards and few fields are mostly below 600 m, in the direct vicinity of the village core. The terraced land used for meadows and grazing can be found up to 750 m above sea level; the forest is overgrowing the terraces to a major extent north of the village, on the eastern slope of Racovnik Kovač Peak, at an elevation of more than 750 m. The terraces there were abandoned early on, and even in the Franciscan cadaster they are already marked as pastures and meadows.

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Lower terraces are characterized by high and relatively steep slopes planted with fruit trees and gently sloping terrace platforms.

More than four-fifths of terraced land lies on slopes with at least a 30% gradient, of which almost a quarter has a gradient of more than 70%. Most of the other terraces are on gradients between 15.1 and 30.0%. The flattest terraced land is in the direct vicinity of the village, at the end of the meandering unpaved route between Mowing Hill and Racovnik Kovač Peak. However, the steepest terraced area lies south of Sušica Creek. The terraces in steeper areas are overgrown with meadow vegetation and are already partly afforested. Due to the high elevation, insolation is a very important factor for the terraces. The aspect is basically dictated by the terrain configuration, which is why shady northwest exposures on the one hand and sunny southwest exposures on the other stand out in the settlement area. The terracing of the land has been thoroughly adjusted to these conditions, so that almost three-quarters (72%) of terraces face southwest, west, or south, actually almost half (47%) have a southwest exposure. Only the already afforested terraces on the slopes of Racovnik Kovač Peak have an eastern, northeast, or northern exposure (20%).

As already mentioned, cultivation of crops has almost completely disappeared in Smoleva. It never involved market production because all of the crops were used at home. On the other hand, the locals already started seeking income from non-agricultural activities in the past, at first in ironworking and for the last fifty years in factories and offices in the valley. One can learn the most about modern aspirations regarding land use from statements by the locals (F. Jelenc 2014; M. Jelenc 2014; O. Torkar 2014; R. Torkar 2014). Meadows now cover almost all agricultural land, which is partly mowed with tractors and partly by hand. The farmers regularly maintain the meadows because it is the only way to continue receiving agricultural subsidies. This is also why no further abandonment of agricultural terraces has been detected. In addition to mowing the terraced land, they also remove new bushes and, to the extent that they are able, repair damage to the terrace slope, which occurs because of regolith creep. The agricultural subsidies do not include special-purpose assets necessary for technical maintenance of the terraces.

The ownership of the terraced land is fragmented. A terrace platform and its slope are exclusively owned by one farm, but the land of individual farms is not connected into contiguous units due to past inheritance. In the past decades, there were more so called »protected« farms (partition of such farm was strictly forbidden), but now only a few attain the necessary size required for protection. The requirement that the protected farms must very precisely fulfill is land management (active use, manner of manuring and mowing, etc.). On smaller farms there is a risk that a change of owner or operator could lead to the abandonment of further agricultural land use. The potential for further landslides poses an even greater threat.

The local population used microtoponyms to name individual terraces. These names are commonly known among the villagers and they facilitate their orientation: *Na njivi* »on the field«, *Na Smolevš* »on Smolevš«, *Na ravni njivi* »on the level field«, *V dolini* »in the valley«, *Pod dežo* »below the hollow«, *Pri zadnji dolini* »at the last valley«, *Laz* »clearing«, *Kladje* »blocks«, *Zavrh* »behind the peak«, *Sitarjeva usadnica* »Sitar's little slump«, *Francetova usadnica* »France's little slump«, and others. Some identify even more strongly with the terraces and point out their contribution to the panorama of their home area, which has been part of their lives since childhood. The terracing of the land does not bother anyone, although some believe that land could be cultivated in a different way with more modern technology. Some remember that initiatives to level the terraces were advanced decades ago, but such ideas were abandoned because of landslides. The locals do not recognize the terraces as an important element of the cultural landscape that could attract a larger number of visitors, although Smoleva is already a popular destination for walkers and hikers, especially from nearby Železniki (F. Jelenc 2014; M. Jelenc 2014; O. Torkar 2014; R. Torkar 2014).

The sample area for the **Alpine plains** is the village of **Rodine** (565 m), a clustered settlement on the northeast edge of the Radovljica Plain, also known as Dežela »country« (Topole 1995), at the transition from the plain into the slope of the Reber Ridge, which runs parallel to the Peči Ridge and the Karawanks, below their highest peak Mount Stol (2,236 m). The terraced land is clustered in two areas of the settlement, in its southeastern and northwestern parts. Individual terraces can also be found in the western part of the settlement.

The surface of the area was largely reshaped by a glacier. A low rise is reminiscent of its activity – a moraine embankment that protrudes from the surrounding plain north of the village center. The moraine material was used in the past for paving the roads and for construction (Miklavčič 1937; Šifrer 1969). Remnants of quarrying are clearly visible on the LIDAR

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In places there are older terrace slopes between the routes, above which there are wider and less steep terrace platforms, which indicates that they were created before the mechanization of farming and forestry.

image. Even some slope processes are shown on the image; for instance, the brightly colored active landslide above the right edge of the terraced area in the eastern part of the village and also a low hill that stretches along the main road from Begunje na Gorenjskem to Žirovnica, an outstanding example of a fossil moraine.

The temperate continental climate of western and southern Slovenia is typical of Rodine (Ogrin 1996). The nearby Lesce meteorological station measured an annual average precipitation of 1,393 mm from 2001 to 2010, with a rainfall peak in the fall. The average January temperatures are below freezing (−1.5 °C), and the July averages approach twenty degrees (19.5 °C; Podnebni kazalniki SURS).

Among the weather characteristics, it should be emphasized that the Karawanks foehn wind thoroughly ventilates the Radovljica Plain. It is generated in a manner similar to that of the bora wind, and so it is also referred to as the Karawanks bora or the northern foehn. It differs from the true foehn in temperature. It blows across the slopes and the foothills with a speed of over 20 m/s and occasionally causes damage to the natural features (by felling trees) and infrastructure (by blowing off roofs; Ogrin 2004). An important climate characteristic of Rodine is its location in the thermal zone, which has a positive impact on farming and living conditions (Gams 1996). On the basis of natural factors, eutric cambisols developed through pedogenesis.

In terms of its location and origin, Rodine is a typical upland Upper Carniolan village. Its name derives from the expression *rodina* »desolate and swampy land« (Meterc 2012) or »land set aside« (Snoj 2009). The oldest evidence of settlement in this area dates back to Antiquity. Below the main road, which runs through the village, the remains of a Roman villa rustica have been probed (Valič and Petru 1964), and this can be identified in the extreme lower part of LIDAR image.

In the Middle Ages, the open sunny area of the Radovljica Plain was also very inviting for colonization. Numerous finds in the direct vicinity of Rodine, in neighboring Smokuč and Žirovnica, testify to this. With the development of ecclesiastical administration on the territory of what is now Slovenia between the tenth and twelfth centuries, Rodine obtained a special place. It became the seat of a proto-parish. At the site of the originally Romanesque Saint

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A panoramic view of Rodine from the southeast.

Clement's Church there probably used to stand a wooden pre-Romanesque chapel. At the beginning of the fourteenth century, the seat of the proto-parish was relocated to Radovljica (Meterc 2012).

When describing Rodine, one must not forget its important transport location. Important routes have run through this area since the Iron Age. The most important was certainly the »foothill corridor,« which led from the foothills of the Karawanks and than from Kamnik through the Tuhinj Valley (*Tuhinjska dolina*) toward Pannonia. In Antiquity, a route led from Carinthia towards the Slovenian Littoral, part of which is now called *Večna pot* »the Eternal Route«. Several important transport connections branched off from this route that were important for the development of settlements in the Middle Ages. In the sixteenth century, a commercial road was built southwest of Rodine, called *Karlova cesta* »(Archduke) Charles Road«, which connected the Koren Pass (*Korensko sedlo*) and Ljubljana and was intended for wagons. The Imperial Road (*Cesarska cesta*) built in the eighteenth century, which contributed to overall economic growth, bypassed the village (Jarc 2004).

A LIDAR image of the area around Rodine.

According to data from the first census from 1869, Rodine was home to 87 people. Until 1931, this number fluctuated, but it has been constantly rising since then, especially from 1960 to 1990. According to data from 2015, 348 people live in Rodine (Slovenian Statistical Office 2015). The ratio between young and old inhabitants favors the elderly, but the situation is not alarming. Many new buildings have become homes to young families, which is improving the age structure alongside the elderly rural population.

Rodine is also important from a cultural history aspect. The writer Janez Jalen was born here and the cultural heritage trail that connects the villages below Mount Stol – beginning with the birthplace of the »greatest« Slovenian poet France Prešeren and Archbishop Anton Vovk in Vrba and then Doslovče, where the writer Fran Saleški Finžgar was born, Breznica, the birthplace of the renowned beekeeper Anton Janša, and Žirovnica, where the linguist Matija Čop was born – ends in Rodine in a way.

In the northeastern part of the Radovljica Plain, agriculture was an important economic activity during all periods of history due to the favorable natural conditions. Close to Rodine, in the Vrba Plain, even tobacco was experimentally

planted in 1951 and grown for some years until it was destroyed by heavy hail (Koselj 2008). There is also a strong connection between agriculture and terraces, which take up just over 22 ha of land or 12.4% of the village's territory. Terracing the landscape was an attempt to gain more land suitable for farming. The terraces in northwest Upper Carniola are not a very distinct landscape element, and so they are rarely mentioned in the literature. However, they are not only typical of Rodine. They can also be found in Gorje, where in the past they were mainly used to grow currants, and they are also characteristic of Dovje, villages Srednja vas and Češčjica in the Upper Bohinj Valley (*Zgornja Bohinjska dolina*), the Lancovo and Ribno areas near Lake Bled (*Blejsko jezero*), and one can encounter them in a number of other places.

A good three-fifths (61.4%) of Rodine's terraced land lies in the 500 to 550 m elevation zone, and the rest is located in the 550 to 600 m zone. Almost three-quarters (72.2%) is on gentle slopes with a 15.0% gradient, whereas the great majority of the rest (24.8%) is on moderately steep slopes with a 15.1 to 30.0% gradient. The bulk of the terraced land has a southwest aspect with favourable sun exposure (63.5%), followed by southern (17.3%) and western (12.3%) orientations. Other aspects occur in negligible percentages. Comparing the orientation of the terraced land in Rodine to other sample areas, it can be concluded that Rodine has the largest share of southwest aspects of all.

The first relatively accurate data on agriculture in the Radovljica Plain can be found in the protocols and maps of the Franciscan cadaster. There were eighteen farms in Rodine that owned 178 plots, which corresponded to 12.6% of all plots in the tax district. Meadows and pastures prevailed (Sinobad 1998), whereas fields made up the bulk of the terraced land (55.1%). Only the northeast part of the settlement was covered with forest.

During this period, the Rodine farmers abandoned the fallow land and started practicing crop rotation. This can be determined from the assessments in the Franciscan cadaster. They introduced a ten-year crop rotation. In the first year they would fertilize the soil extensively and sow barley, immediately after that, in the same year, they would sow clover, and the next year they would sow only clover without fertilizing. The third year they would fertilize the soil and sow millet, and the fourth year it was wheat, followed by buckwheat. The sixth year they would first fertilize the soil and sow corn, wheat in the seventh year and buckwheat after that, in the eighth year they would again fertilize the soil and sow rye, then follow up with buckwheat, in the ninth year it was once again time for fertilization and then they would sow oats. In the final year they would fertilize the soil as well and sow potatoes. In addition to these crops, the farmers also grew cabbage, turnips, beans, carrots, broad beans, and flax for their own needs. The only cereal grown for market was wheat. To prevent smut, they used to soak the seeds in lime before sowing (Sinobad 1998). The Radovljica Plain is characterized by the distribution of fields into rectangular parcels. Typically these fields are bordered by narrow strips of pasture or meadows. Generally they are rectangular and elongated. This field pattern, which indicates old colonization according to Ilešič (1950), is also typical of the terraced land in Rodine.

In addition to food and fodder cultivation on the fields, pastoralism was also developed. The Rodine farmers put their livestock out to pasture on the slopes of the Reber Ridge, and they also had grazing rights on the Smokuč and Zelenica mountain pastures (Jarc 2004; Sinobad 1998). The pasture season began on Midsummer Day, June 24th, and ended on the Nativity of the Blessed Virgin, September 8th. By engaging in mountain grazing, the farmers could rear more livestock, but they had to put away enough hay for the winter when the livestock was in the barns (Jordan 1945).

The highest-quality meadows produced fine hay, while the upland and mountain meadows produced mixed and coarse hay. The second-growth crop was only mowed on the highest-quality meadows. The meadows surrounding the houses were used for growing fruit trees, mostly apples, pears, and plums. The fruit was mostly used for distilling spirits.

The Rodine farmers had shared mixed forests in Za Vrhom »behind the, in the upper part of Završnica Creek. There they collected leaf litter, but they also used the area for forest grazing. They cut the trees in the spring, limbed them in the fall, and hauled the logs to the valley in the winter (Sinobad 1998).

Nearly half of the livestock were sheep, followed by cows and pigs. Around a quarter were horses, oxen, and young cattle. From the fleece they made wool, but they also raised sheep for slaughter and milking, mainly in the mountains. In the winter they mostly fed them on dry leaves and weeds.

Rodine is also important for beekeeping. The former rectory used to be the headquarters of the first beekeepers' society in Slovenia, which

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The terraced area in Rodine consists of indistinct grassy terraces with gently sloping terrace platforms and very gentle terrace slopes.

was founded on April 14th, 1781. It was named the Beekeepers' Brotherhood (*Čebelarska bratovščina*) (Zaletel 1995, 1996). The knowledge of beekeeping that developed in Upper Carniola over several centuries was enriched by the discoveries of Anton Janša, who became the most important teacher of beekeeping in Austria, and Maria Theresa decreed that his manner of beekeeping be used across the entire monarchy (Sinobad 1998).

Over time, the land-use categories on village land changed; for both terraced areas in Rodine it is mainly the area of fields that has decreased (this now only amounts to 6.9%). The share of meadows and pastures has especially increased, now representing 83.6% of the terraced land. Orchards make up 4.1% of the village's terraced land, and the same percentage is occupied by buildings. Less than one percent (0.7%) is uncultivated, and an area of the same size has already been overgrown by forest. There is no terraced land currently undergoing afforestation.

Overgrowth and afforestation are therefore not an issue in Rodine. The reason for this must surely be the intentional cleaning of the terraced land under joint (communal) ownership, which was carried out some time ago. They even assisted themselves with mechanization, removing bushes and trees by their roots, as well as sowing the cleaned fields with grass. A substantial amount of manual labor was also carried out (Meterc 2014).

The Rodine terraces are hard to classify in one general typology because the authors that have dealt with this subject (e.g. Ažman Momirski and Kladnik 2009; Križaj Smrdel 2010b) have so far not devoted any special attention to it. Ažman Momirski and Kladnik do mention them and classify them as an tilled terrace type, but, according to the Križaj Smrdel typology, the Rodine terraces most closely resemble those in Lower Carniola, except that they have lower and more gently inclined slopes. The terraces in Rodine were created on the foothills of the Reber Ridge. Slope rubble and fairly unstable gravel accumulated there. To prevent the negative effects of erosion, terraces were created. If they did not exist, intensive farming would probably not be possible in this area. In the past, the fields on terraces were plowed with horses, and in the contemporary machine age with tractors. They also used to be mowed manually, but now this is done exclusively with machines. Because the grassy earthen terrace slopes are very slightly inclined and relatively low (up to 1 m, with some exceptions), mechanical cultivation does not cause any serious problems. The terrace platforms with a slight outward slant are namely quite wide (even upwards of 10 m) and relatively long (Čop 2014), generally between 50 and 100 m, and in some places even more than 200 m.

The locals perceived the terrace slopes as »additional« farmland where grass grew, which they would not have had if the landscape were flat. They had a similar view of the piles of rocks that they removed when they cultivated the fields. Even though they had the opportunity to remove the rock piles at the expense of the municipality, many were against it because it would have cost them some land (Čop 2014).

A special feature of the Rodine terraces are the two stone embankments or dry stone walls northwest of the village church. Both are relatively well preserved and they still serve their purpose.

The locals will tell you that the village cemetery used to lie between them (Meterc 2014). This is also indicated by the microtoponym *U Britof* (Standard Slovenian: *V Britofu* »in the cemetery«; Jarc 2004) and some chance finds. The other microtoponyms used for the terraced land are also well recognized among the locals. The terraces east of the village core are called *Polane* (Standard Slovenian: *Poljane* »large fields«; Meterc 2014; Čop 2014; Jarc 2004). The name *Poljane* is an augmentative of the word *polje* »field« (Snoj 2009), which is certainly connected to the past agricultural usage, also evident from the Franciscan cadaster. The terraces northwest of the village core are called *Dele* (Standard Slovenian: *Dela* »works«; Meterc 2014; Čop 2014; Jarc 2004). It is said that the pastures in Dele were rearranged into fields in 1600 and the year of the arrangement was carved into a rock, which can still be clearly seen (Meterc 2012).

The terraced fields in Rodine had no major effect on the expansion of the village because they are not construction land (Meterc 2014; Čop 2014). Nonetheless, if one compares land use in the Franciscan cadaster and modern-day use, it can be concluded that the changes toward building up the land are significant because the share of built-up terraced land has risen from 0.8% to 4.1%.

The residents of Rodine do not perceive the terraces as an especially prominent landscape element, but they do think that the terraced land is still somewhat more attractive than a flat landscape or a slope with a uniform gradient. In any case, they are opposed to any destruction of the terraces because they worry about potentially more intense erosion. They have already had some negative experience with this. They are not thinking about including the terraces in tourism activities (Meterc 2014; Čop 2014). Tourism is not a particularly developed or significant part of the economy here, but it would be worth considering and including Rodine's cultivated terraces in the Cultural Heritage Trails system. Even though terraces can be found in several areas in Upper Carniola, it is here that they are closest to tourist routes, although the tourists are mostly school groups that visit the neighboring villages. A word or two about terraced landscapes when traveling from Begunje to Doslovče would not be amiss in any case, and it could broaden many horizons.

PANNONIAN SLOVENIA

The Pannonian landscapes in the eastern and northeastern part of Slovenia extend across 4,292 km², which is a fifth of Slovenian territory. The landscapes' terrain is predominantly hilly and in some parts mountainous (2,995 km²), and only a good third of it comprises plains (1,297 km²). The hilly mesoregions include the Goričko region, the Lendava, Slovenian, and Haloze hills (*Lendavske gorice*, *Slovenske gorice*, *Haloze*), the Boč Hill and Macelj Hill (*Boč in Macelj*), and the Dravinja, Voglajna, Upper Sotla, Central Sotla, Krško, Senovo, and Bizeljsko hills (*Dravinjske gorice*, *Voglajnsko gričevje*, *Zgornjesotelsko gričevje*, *Srednjesotelsko gričevje*, *Krško gričevje*, *Senovsko gričevje in Bizeljsko gričevje*). The flat areas of land consist of the Mura, Drava and Krka plains (*Murska*, *Dravska in Krška ravan*), whereas Mount Boč (879 m), Mount Donat (*Donačka gora*), the Macelj Hill, and the Western Haloze and Krško Hill have typically hilly terrain.

The majority of the hills are made up of tertiary and quaternary sedimentary rocks, such as marl and sandstone, as well as clay and silt. The Drava and Mura plains are covered with siliceous gravel, whereas the Krka Plain is covered mostly with calcareous gravel (Belec 1996; Gabrovec and Hrvatin 1998; Verbič 1998). These landscapes have a temperate continental climate with 800 to 1,000 mm of rainfall per year, most of which occurs during the summer (Ogrin 1996, 1998).

There are approximately 540,000 people living in the Pannonian landscape (Registrski popis 2011). In the hills, the population figures have changed only slightly in the last 140 years: from 235,000 in 1869 to 250,000 in 2011. In contrast, the population grew by two and a half fold – from 115,000 to 290,000 – in the plains, where most of the cities are located (Savnik 1976, 1980; census data).

Altogether, there are 5,646 ha of terraces, which is 1.32% of the territory. In terms of terraced areas in Slovenia, the Pannonian landscapes are second only to the Mediterranean ones. Almost all terraced land, 5,575 ha, is found in the hilly regions. In terms of the basic topology (Ažman Momirski and Kladnik 2009), the terraces are divided into vineyard terraces, predominantly found in the Haloze, Slovenian, and Drava hills; tilled terraces in the Goričko region, in the Boč and Macelj mesoregions, and in the hilly areas on the right bank of the Sotla River; and orchard terraces, prominent in the Voglajna Hills and Krka Plain.

Nine-tenths of the terraces are located at an elevation of 200 to 400 m. Terraces on higher ground can be found only in the Dravinja Hills, the Krško, the Senovo and Bizeljsko hills, on Mount Boč and Mount Donat, and in the Macelj Hill (up to an elevation of 700 m). Terraces that are more elevated have a prominent south, southeast, or southwest exposure. Lower-elevation terraces are almost equally divided into those with an eastern exposure and those with a western exposure. The only exception are the terraces in the Goričko region, where more than half have one of the northern exposures. Two-thirds of terraces are located on slopes with an incline up to 30%. Terraces on steeper hillsides are found mostly in the Haloze (65%) and Boč and Macelj (60%) mesoregions.

Vineyard terraces are very alike because they were made in a uniform, mainly mechanical manner. The terrace platforms are narrow, only 2 to 3 m wide. The grapevines are usually planted in a single row on the terrace slope. On fields and meadows with lower inclination, the terrace slopes are lower and the platforms are wider. Based on their form, they belong to the type of terraces with evenly inclined slopes and platforms that slant outward (Križaj Smrdel 2010a).

Vineyards occupy 29.5% of all terraced land. Vineyard terraces are a new phenomenon in the cultural landscape; they were introduced on a large scale only after 1960. In many places in the last decades, people started abandoning such terraces and once more began prioritizing vertical vineyards, which are said to increase yields and limit the spread of grapevine pests (Ažman Momirski and Kladnik 2009; Križaj Smrdel 2010a, 2010b).

Compared to vineyards, an almost equal share of land is taken up by meadows and pastures (29.4%), which largely replaced the once distinctly predominant fields (17.8%) on tilled terraces. The terraced land in the Goričko region is still primarily used as fields. Due to the abandonment of terraced vineyards, the percentage of uncultivated terraced land is above country average (3.7%), whereas the share of land being overgrown (8.1%) remains, at least for now, slightly below the national average. The percentage of terraces that have undergone afforestation is also substantially smaller (2.1%).

The sample area for the **Pannonian low hills** is the village of **Jeruzalem**, a scattered, wine-growing settlement, located partially on a ridge in the heart of the Ljutomer–Ormož Hills (*Ljutomersko-Ormoške gorice*), which make up the eastern part of the Prlekija region. The settlement's small and compact core is found on a ridge (338 m) and in its center is Our Lady of Sorrows Church, which was built in 1652 and can be seen from far and wide (Belec 1995; Curk 1990; Kert 1998; Šedivy and Belec 1980). The settlement is spread across 59.8 ha of land and it is the most terraced sample area out of the eight sample areas that we examined in detail, even though it is the smallest: the terraces cover a full 24.5 ha, or 40.9% of the settlement's territory. The formation of these terraces, which are the most recent among the terraces from all of the sample areas, is closely linked to the expansion of viticulture in the Ljutomer–Ormož Hills (also known as the Eastern Slovenian Hills (*Vzhodne Slovenske gorice*) owing to their position as part of the most extensive Slovenian hills (*Slovenske gorice*), and by some as the Jeruzalem Hills (*Jeruzalemske gorice*) due to their old informal center (Lusković and Sakelšek 1994).

Until 2015, thirty-three people lived in Jeruzalem, none of whom were younger than fifteen (Slovenian Statistical Office 2015). When the first census was carried out in 1869, the settlement had fifty-nine residents. Except for a pause at the end of the nineteenth century, the population gradually continued to grow until 1961, when it reached its peak at ninety-three inhabitants. At that time, the population began to decrease quite markedly, and the figures are still falling because the population has decreased by a fifth in the last few years (from 2011 to 2015).

Essential to the development of viticulture are favorable soil and weather conditions. The Jeruzalem area, like some other parts of the Slovenian Hills, is made of loosely consolidated Neogene rocks, which have poor resistance to erosion. Sand, clay, and marl are the predominant components, whereas there is less sandstone and limestone. The oldest sediments are from the Lower Miocene and they are deposited on a metamorphic foundation. These sediments are comprised of layers of sandy marl, sandstone, sand, and conglomerate. Landslides are a frequent occurrence with such sedimentary rocks (Kert 1998). The soil on hilltops and steep slopes is sandy and loose, whereas less steep hillsides at lower elevations

◀ The dynamic slopes of the Eastern Haloze Hills are one of the most attractive Pannonian terraced landscapes, with vineyard terraces following the contour lines on the sunward sides and woods on the shady sides.
MATEVŽ LENARČIČ

have heavier, loamier soil with an admixture of clay particles (Luskovič and Sakelšek 1994). The LIDAR display clearly shows forested erosion hotspots at the bottom of the valleys that are already cutting into lower-lying vineyard terraces as they expand upwards.

Jeruzalem has the characteristic temperate continental or sub-Pannonian climate of eastern Slovenia and a continental precipitation and temperature regime, usually with 800 to 1,000 mm of rainfall per year and with average April temperatures that are equal to the October ones or even higher (Ogrin 1996). The thermal zone, which begins at 15 to 40 m from the bottom of the valleys and, in the Jeruzalem area, extends to the top of the hills, guarantees higher temperature minimums at night, as well as higher average annual and daily temperatures than those at the bottom of the valleys (Ogrin 1998). The lower vineyard limit in the Jeruzalem Hills coincides with the microclimatic boundary, set by a higher probability of frosts down in the valley. In western and eastern exposures, this dividing line is found at an elevation of 250 m, which is 40 to 50 m from the bottom of the valley, whereas it is significantly higher in northern exposures (Belec 1968).

The traditional land partition of vineyards was varied and it depended completely on terrain features that man had little influence over prior to creating vineyards. The boundaries between the vineyard plots, which were cultivated solely by hand for a long time, had ditches to drain excess rainwater. Every vineyard plot was laid out to make maximum use of the terrain, which included not only an optimal number of grapevines planted, but also the most efficient use of water, sunlight, and heat, accessibility and traversability, and the easiest means of manual cultivation. Only old photographs make it possible to envision the diversity of the vertically planted grapevines, with rows running down along the slopes – which, based on their appearance, could also be referred to with terms other than »vertical vineyards« (Pavličič 2016). Belec used the expression »traditional staked vineyard« due to the fact that every grapevine was tied to its own stake and the vines were not connected to each other with a wire trellis and therefore did not form rows, which is why these vineyards differed notably from the long-rowed vertically planted vineyards that are familiar today.

Since the sixteenth century, strict viticultural regulations, known as the Vineyard Law Code

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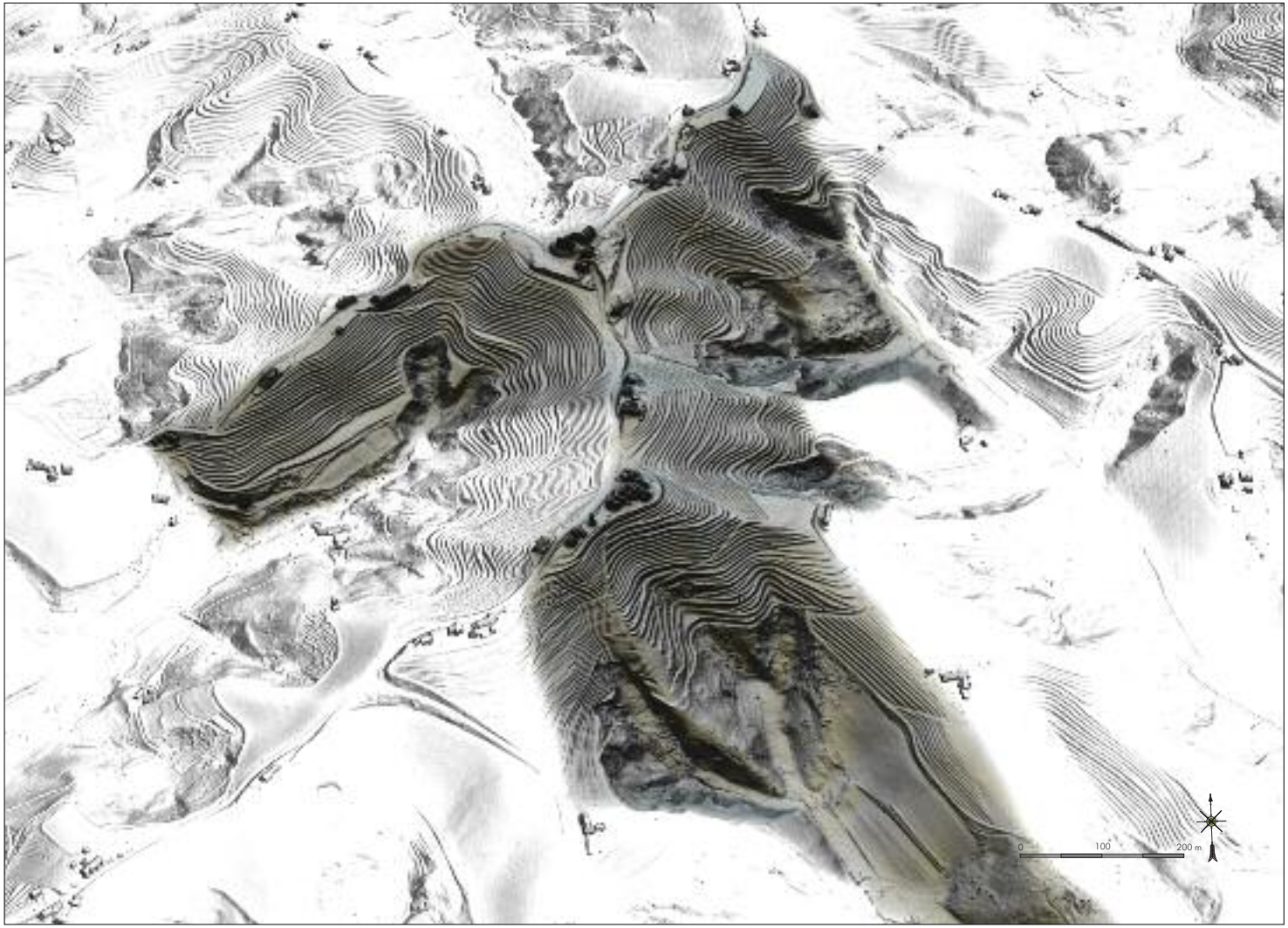
A panoramic view of Jeruzalem from the northeast.

(*Gorske bukve*), have defined in detail how vineyards are worked, even in terms of soil quality, extent of specific works, and drainage, to prevent damage to neighboring vineyard plots (Pavličič 2016).

Already under the Austro-Hungarian Empire, the soil quality was analyzed and the ideal vineyard exposures were determined. The danger of landslides was also taken into account. In order to prevent land slippage, people started planting fruit trees and afforesting problematic plots. Decorative Lombardy poplars (*Populus nigra* »Italica«; Internet 5) on the tops of the hills not only provided shade along trails, but also helped drain the surrounding area (Pavličič 2016).



A LIDAR image of the area around Jeruzalem.

In the past, the hilltops of the Eastern Slovenian Hills, which were warmer and drier than the rest of the hill, were inhabited by vinedressers, who were the workforce, and winegrowers, who owned the vineyards (Pavličič 2016). In these scattered settlements, both sides of the roads, which run along the ridges and up to which the vineyards stretch, are dotted with vineyard cottages and cellars, walls, and stakes (Luskovič and Sakelšek 1994).

Already when the Franciscan cadaster was introduced, a very large share of vineyards in the Jeruzalem Hills were owned by nonlocals (Valenčič 1970). Owners usually lived far away from their vineyards. At first, the workers were allowed to live in the buildings next to the vineyards only temporarily and later on they were able to settle down permanently with their families. In this way, the social class of vinedressers was formed and the vinedresser system came into existence (Simonič Roškar 2003).

The majority of the Jeruzalem vineyards were owned by nonlocals, even foreigners, until the end of the Second World War. In neighboring Plešivica, for instance, as much as 45.5% of vineyards belonged to Austrian citizens. After 1945, former vinedressers were able to buy the house and adjoining garden in line with the vinedresser law (Šedivy and Belec 1980), which caused the decline of vinedressing. At the time of industrialization, they found more permanent and better-paid employment, and thus began abandoning the hilly areas, which grew increasingly dependent on mechanical cultivation.

In accordance with the policy of the time, new industrial plants were established in Ljutomer, which employed thousands of workers prior to Slovenia's independence. After the Second World War, viticulture in the Ljutomer–Ormož Hills was converted into a business for small

private winegrowers and large collective vineyards through numerous reforms (Pavličič 2016). Jeruzalem was the boundary between the Ljutomer and Ormož areas. Vineyards located north of the church in Jeruzalem were part of the later Ljutomer Vineyard and Livestock Collective Farm (VKŽ Ljutomer), which was based in Ljutomer, whereas those south of the church belonged to the later Jeruzalem–Ormož Agricultural Collective Farm, based in Ormož. In terms of vineyards, wine cellars, and wine sales, viticultural collectivization made a new approach possible, the most visible form of which was vineyard terracing. The two key factors that motivated vineyard terracing were the lack of labor for manual cultivation and the limited agricultural machinery at the time, which did not allow farming on steep slopes. Therefore, the relatively steep slopes had to be adjusted to the machines' capacity and so the ground was leveled into terraces.

The large-scale vineyard terracing in the Ljutomer–Ormož Hills began in the 1960s, when the state started promoting the development of agriculture by providing favorable bank loans. It followed the example of vineyard terracing in the settlement of Globoka, which occurred prior to the Second World War, and that on Vardovščak Hill, which has been taking place since 1953. In the Ljutomer area, the condition for obtaining a favorable bank loan for viticulture was to have at least 65 ha of vineyards intended for terracing. In 1960, therefore, VKŽ Ljutomer also started preparing for terrace construction in vineyards. The terracing plan for the Ljutomer Hills was completed by the engineers Sluga and Leonardi. After 1965, vineyard terracing began in the areas of Slamnjak, Ilovci, and Železne Dveri, from where the terracing started expanding southward and westward, in the direction of Jeruzalem. Because VKŽ Ljutomer did not have the necessary machinery for terrace construction, the work was carried out by the companies Obnova Maribor and Agrotransport Ptuj. The terrain intended for terracing first had to be leveled, excess vegetation had to be removed, and various indentations and rises needed to be smoothed out. This was followed by staking out the individual terraces, where microterrain conditions had to be taken into consideration. Based on the quantity of marl or loam in the soil, any moving, plowing, subsoiling, and leveling could potentially cause unexpected problems due to land creep. The land was then subjected to deep plowing with a heavy plow, followed by the construction of terrace slopes with various inclinations and the leveling of the cultivated area. When shaping individual terraces, the workers used three-meter-long leveling boards tilted toward a distant point in order for the platform to assume a 3% incline outward.

Some of the pre-planned trails among the terraces later had to be redesigned based on the actual conditions. Similarly, the terrace slopes, which were originally supposed to have a gradient of 45° (100%), proved to be too gentle. In order not to lose too much cultivated land, the slopes' gradient was sometimes increased even to 80° (567%), which made them nearly vertical.

The vineyards north of the church in Jeruzalem were terraced as decided by VKŽ Ljutomer, whereas the ones south of the church were shaped as decided by the collective farm in Ormož. According to the calculations, the final 335 ha of VKŽ Ljutomer's terraced land is said to have produced one-third lower yields per hectare, but much higher yields per individual vine, also aided by the new varieties of grapevines planted. Ultimately, the yield had a higher quality and larger quantity than before (Štrakl 2016; Žličar 2016).

In 1965, the painter Ante Trstenjak depicted one of the last structures of the Jeruzalem landscape prior to the terracing of vineyards south of the church (Pavličič 2016; Trstenjak 1965). An old photograph from 1966 already shows the freshly plowed vineyard terraces near Svetinje (Belec 1968).

The Jeruzalem–Ormož Collective Farm carried out vineyard terracing in a similar manner to VKŽ Ljutomer (Štrakl 2016; Žličar 2016). All of the available land, including the former vinedressers' gardens, was allocated for the creation of terraces. In Jeruzalem, terraces were constructed all the way up to the hilltop houses (Brenholc 2014; Vočanec 2014). Vineyard terracing in the Jeruzalem–Ormož Hills drew to a close at the end of the 1980s (Štrakl 2016; Žličar 2016).

In the Jeruzalem area, 70% of the terraced land is located at an elevation range of 300 to 350 m, and the other 30% is found at an elevation from 250 to 300 m. Interestingly, the terraced land is equally distributed by quarters on slopes with each of the following inclines: up to 15.0% (26.2%), from 15.1% to 30.0% (25.6%), from 30.1% to 50.0% (24.1%), and over 50.1% (24.1%). A full five-sixths of terraced land has a southeast, eastern, southern, or southwest exposure; most is oriented toward the southeast (34%) and east (22.9%). There is significantly more terraced land on sunny slopes (61.1%) than on shady ones (10.9%).

BOJAN ERHARTIČ

Uniformity and harmony are characteristic of the long mechanically created vineyard terraces in Jeruzalem.

It should be noted that such an arrangement of terraces is attributable to the demarcation of Jeruzalem because in the neighboring settlements of Plešivica and Mali Brebrovnik slopes on the shady and western sides of hills are also thoroughly terraced.

According to the Franciscan cadaster carried out from 1819 to 1825, 79% of the currently terraced land, which did not yet exist at that time, was occupied by vineyards. Next were meadows and pastures (11.5%), fields (5.4%), and forests (2.4%). When vineyard terracing took place in the second half of the twentieth century, the share of vineyards on terraced land increased to a full 89.8%. Despite the dominance of vineyard terraces, some older, agricultural terraces, which now serve almost exclusively as meadows and pastures (8.7%), can still be found at lower elevations of the slopes.

In the Jeruzalem–Ormož Hills, the terrace platform is known as a *terasa* »terrace«, *plato* »plateau«, or *vozna površina* »driving surface«, and the terrace slope is referred to as a *škarpa* »scarp« or *šrega* »slant, slope«. The names of terraced areas were derived from old microtoponyms. For instance, a vineyard referred to as *Hinjčevo* »Hinjc's« prior to terracing is now known as *Hinjčeve terase* »Hinjc's terraces«, the former *Ornikovo* »Ornik's« became *Ornikove terase* »Ornik's terraces«, *Fischerauerjevo* »Fischerauer's« became *Fischerauerjeve terase* »Fischerauer's terraces«, and so on (Brenholc 2014; Hrga 2014; Prapotnik 2014; Vočanec 2014). In most cases, therefore, these names were based on the surnames of previous owners.

In the 1990s, the landscape of the Ljutomer–Ormož Hills once again underwent drastic changes due to the rearrangement of terraced vineyards into vertical ones. The reason for such alterations was the development and greater affordability of modern agricultural machinery, which made it possible to cultivate steep slopes. Comparing terraced vineyards with vertical ones, the latter make it possible to plant up to 60% more grapevines per land unit. This in turn makes possible easier and more economical cultivation, and also generates a greater profit, which is due not only to high yields, but also to agricultural subsidies (Hrga 2104; Prapotnik 2014). This practice has, at least for now, bypassed Jeruzalem, but it is already very prominent in the settlement's immediate vicinity.

The former Jeuzalem vineyard owners, whom the vineyards were returned to after denationalization, decided to preserve their terraced form, as did the successors of both collective farms. We even observed that a new owner created terraces on a slope that previously had no vineyard. Due to lack of knowledge and experience, the terraces were unfortunately constructed on wet and unsuitable ground, which soon led to problems with slumps (Brenholc 2014; Vočanec 2014).

The terraces in the Jeruzalem area are a recent manmade landscape characteristic with barely half a century of tradition. Although the terraces' initial purpose was to help man cultivate exceptionally steep slopes in the Eastern Slovenian Hills, they are now highly valued mostly because they satisfy certain aesthetic criteria. The terraces in Jeruzalem are undoubtedly valuable and should be preserved because geometricized terraced slopes, which extend along contour lines and were completed with filigree precision, and where the terraces curve in line with the shape of the terrain, are an important economic asset from the point of view of tourism development (Erhartič 2009b). Well aware of this fact are various stakeholders – from winemakers, who have used the name *Terase* »terraces« for a local wine, to advertising campaigns, which make use of the Jeruzalem terraces to promote the region's beauty. Terraced vineyards have gained such an important role in the cultural landscape that Jeruzalem and the Jeruzalem Hills were added to the Slovenian Registry of Immovable Cultural Heritage under index number 7867 and made part of Slovenia's protected cultural landscapes.

PRIMOŽ PIPAN

The terraced landscape in the immediate vicinity of Jeruzalem is threatened by large-scale rearrangement of terraced vineyards into vertical plantations, the first harbinger of which is freshly leveled land without vegetation.

NONAGRICULTURAL TERRACED LANDSCAPES

When discussing terraced landscapes, the first thing that comes to mind are almost exclusively agricultural cultural landscapes. At the mention of terracing, however, even a geographer with average knowledge may recall images of fluvial, abrasion, chemogenic, or other natural terraces, which were created solely by the influence of natural forces. In contrast – with the exception of agricultural terraces and the architectural concept of a paved space located on part of a building or near it – geographers are nearly unaware of other terraced forms that are a result of human activity.

Because this book deals with terraced landscapes, it seemed appropriate to include a brief and systematic presentation of terraced landscapes or groups of terraces that were created by both man and nature. To this end, the available photographic material was systematically reviewed and classified, whereby terrace patterns have even been found beyond our planet.

In classifying nonagricultural terraces, only an initial attempt at categorizing them into general groups was carried out; with natural terraced landscapes, the focus was placed on their formation and the predominant factor that helped shape them, and their dimensions were also considered. With manmade terraces, attention was directed to their functional aspect: to the primary role the terraces have in human involvement. We are aware that it is possible to devise a more detailed categorization, as well as present further different types of terraces; regrettably, however, the space at our disposal does not permit this.

Before continuing, allow us to point out a specific type of biogenic terraces that were created by grazing livestock, and are thus a combination of both natural and manmade aspects. They were classified as natural terraces.

BOJAN ERHARTIČ

Small terraces of white desert sand made of gypsum crystals at White Sands National Monument in New Mexico.

BOJAN ERHARTIČ

A terraced multistory pueblo (Native American settlement, built between AD 1000 and 1450) in Taos in the American state of New Mexico.

◀ Ice terrace at the end of the Hooker Glacier on New Zealand's highest mountain, Mount Cook (a.k.a. Aoraki). SHUTTERSTOCK

NATURAL NONAGRICULTURAL TERRACES

Step-like landforms that resemble terraces and are the result of natural processes exist in many regions. The basic distinction and categorization of these structures was made in line with the predominant factors and processes that helped shape them. Depending on how they were created, natural terraces can be divided into structural, fluvial, lacustrine, marine, glacial, chemogenic, and biogenic terraces. Based on the size of the feature and its location, two additional types of terraces can be distinguished: microterraces and extraterrestrial terraces.

- **Structural terraces** and other landforms are formed because of differences in certain types of rocks' resistance to external geomorphic factors – or, in other words, due to selective weathering (Migon 2006). Typical structurally conditioned forms that are not influenced by the climate are cuestas (Schmidt 1994), which form on tectonically tilted sedimentary rocks with various degrees of resistance. These are asymmetrically shaped parallel ridges, the sides of which are shaped by different processes due to the differences in rock composition and incline. The variation of rock properties in a small area makes possible the formation of small irregularities, measuring at most up to several meters, on the rock surface, giving the landscape a step-like appearance.
- **Fluvial terraces** are flat land areas that were shaped by rivers before these incised the valley bottoms through erosion. Fluvial terraces are separated from the surrounding land at lower or higher elevations by scarps. These terraces are created when there is a change in the water flow or quantity of the transported material, which increases the stream's erosive capacity (Wolman and Leopold 2013). This may occur due to a lowered erosion base level, a reduced quantity of material available for

VADIM PETRAKOV, SHUTTERSTOCK

Beautiful pools as example of chemogene terraces are located in Huanglong National Park, Sichuan, China.

◀ Fluvial and structural terraces in the semi-desert landscape of Canyonlands National Park in the American state of Utah. BOJAN ERHARTIČ

Pancake Rocks: small limestone terraces on the west coast of New Zealand's South Island. FILIP FUXA, SHUTTERSTOCK ▶

Chemogene terraces on a river in the province of Guizhou, China. SHUTTERSTOCK ▶▶

transportation, or an increased discharge. Terraces at multiple levels represent rivers' individual incision periods (erosion terraces) with intervening phases of incision stabilization, when the valley bottom retained a certain elevation for a long period of time, or phases of reaccumulation of material on the river's floodplain (accumulation terraces; Harden 2006).

• When the water level in a lake falls, an undulating surface that resembles terraces can form on its shore. If the lowering of the water level occurs gradually, the levels or **lacustrine terraces** that are created are more pronounced (Damnati et al. 2015). These terraces can form on either loose shore sediments or on compact bedrock. A lake's water level oscillates in line with climate changes and, in the last century, mainly due to man's excessive water use.

• **Marine terraces** are step-like formations near the coast, similar to cliffs, that can have multiple levels. The cliffs are a result of the waves' mechanical action on the coastline (abrasion), during which various types of cliffs retreat at various speeds and platforms and notches cut by the waves form below them (Sunamura 1992). Due to tectonic shifts or sea-level oscillation during the Quaternary, some cliffs became more distant from the marine coast and thus became inactive (paleocliffs).

• **Glacial** (or **kame**) **terraces** are formed on the sides of glaciers, above the melting ice and between moraines and hillsides. These terraces are shaped like elongated shelves that run along steep valley slopes. They are often divided into smaller parts and are wrinkled due to presedimentation in the post glacial period. These terraces differ from moraines due to their types of sediments; the material deposited in the kame terraces does not come from the glacier, but is accumulated at the sides of the glacier by fluvial processes, which carry this material to depressions filled with stagnant water. For this reason, the sediment composition of kame terraces is highly varied: from rubble and gravel to alternating layers of silt and clay.

• **Chemogenic terraces** predominantly arise through chemical precipitation of calcite ($CaCO_3$) from water, and rarely through precipitation of other mineral compounds (Ford and Pedley 1996). When surface waters that are rich in calcium carbonate pass through sections of riverbeds with a fair amount of vegetation, plants absorb carbon dioxide from water and tufa begins to precipitate. These deposits reshape the riverbeds in such a manner that the water begins cascading from pool to pool, as can be seen, for instance, in the case of the tufa waterfalls of the Krka River or Plitvice Lakes in Croatia. Similar structures can be formed by the precipitation of travertine from thermal waters, when the gases dissolved in water are released at its source, as observed in Pamukkale, Turkey or Yellowstone National Park in the United States. In caves, flowstone is deposited from water due to carbon dioxide (CO_2) escaping into the cave's atmosphere with a lower CO_2 level. In caves flowstone can form rimstone pools, which resemble terraced pools.

• **Biogenic terraces** are landforms that are composed of various organisms' skeletons or are a result of these organisms' activity (in the environment). This category includes calcium carbonate coral reefs, which are made from the corals' skeletons. Due to oscillation in sea level during the Quaternary, which is the result of the alternation of glacial and intergalacial periods or vertical tectonic shifts, the coral reefs can become fossilized. They may comprise many levels, which makes them similar to terraces. Partially biogenic in origin are the horizontal, shelf-like landforms known as terracettes, which are aligned transversally to the hillsides. They usually form on the unconsolidated ground of steep pastures, but they can also arise on forested hillsides. These landforms are up to half a meter high, approximately at a meter's distance from each other, and can be several meters long. Because these forms occur in many parts of the world with different climates, it is not completely clear how they are formed. Although their origin is most frequently associated with grazing animals, which are said to create such terraces by continuously walking along contour lines, an important role is undoubtedly also played by slope processes. Crucial to their formation is the slope's incline, which on average must be greater than 30° or 57.8% (Ward 2006).

• **Microterraces** can be small irregularities on the surface of various and usually unrelated natural phenomena, which also resemble terraces. They are usually formed by gradual loosening and shifting of material in various aquatic or eolian environments. These terraces generally have linear, rhomboid, undulating, or other symmetric forms, and their highest peaks or ridges are oriented transversally to the movement of the material. Some of these formations are impermanent and change quickly, such as waves on the surface of water and the ridges of sand dunes. Others, however, change slowly, such as the furrowed surface of glaciers or the wrinkled surface of speleotherms and other cave features.

• **Extraterrestrial terraces** are a particular type of natural terraces or step-like landforms on other celestial bodies, the detection and observation of which has been made possible by the latest space technology. Although people have known about the Moon's furrowed terrain since the seventeenth century, a variety of morphological phenomena were revealed in detail only through photographs of other celestial bodies' surfaces in the last couple of decades (Baker 1984). At first, the focus was on the planets of the inner solar system with rocky surfaces, which are Mercury, Venus, and Mars (Baker et al. 1992; Baker 2001; Baioni, Zupan Hajna and Wezel 2009; Balme and Gallagher 2009). The outer planets are composed mostly of gases and, although they do not have a solid surface, several of their moons do (Baker 2004). Only recently have photographs shown that dwarf planet Pluto also has a scaly surface, referred to as snakeskin (NASA 2015), which resembles terraced landscapes. Diverse landforms found on other celestial bodies are the result of a variety of processes: from meteor strikes, volcanic activity, tectonic deformation, slope and eolian processes, and fluvial modifications to the effects of glaciation (Baker 2004).

◀ Rubble terraces on a lateral moraine of the Nuptse Glacier south of Mount Everest. DANIEL PRUDEK, SHUTTERSTOCK

SHUTTERSTOCK

A fresh fluvial terrace in accumulated gravel on a Himalayan river.

BOJAN ERHARTIČ

A floodplain and series of fluvial terraces in the Altai Mountains.

SHUTTERSTOCK

Small terraces on the shore of a seasonal lake in Namibia.

MATEJA FERK

A distinct abrasion terrace on the south shore of Australia.

SHUTTERSTOCK

Travertine terraces on the Krka River in Dalmatia.

SHUTTERSTOCK

Travertine terraces in Yellowstone National Park.

BOJAN ERHARTIČ

Travertine terraces next to a hot spring in Yellowstone.

EHTIRAM MAMMADOV

A microterrace pattern on a rock surface.

CHRISTOPHER GARDINER, SHUTTERSTOCK

A structurally conditioned terraced waterfall in Canada.

BOJAN ERHARTIČ

Colorful structural terracing of a hill in Oregon.

SHUTTERSTOCK

Microterraces on an abrasion platform at the seashore.

JAKA ORTAR

Biogenic terraces below Mount Klek in the Karawanks.

KENNY TONG, SHUTTERSTOCK

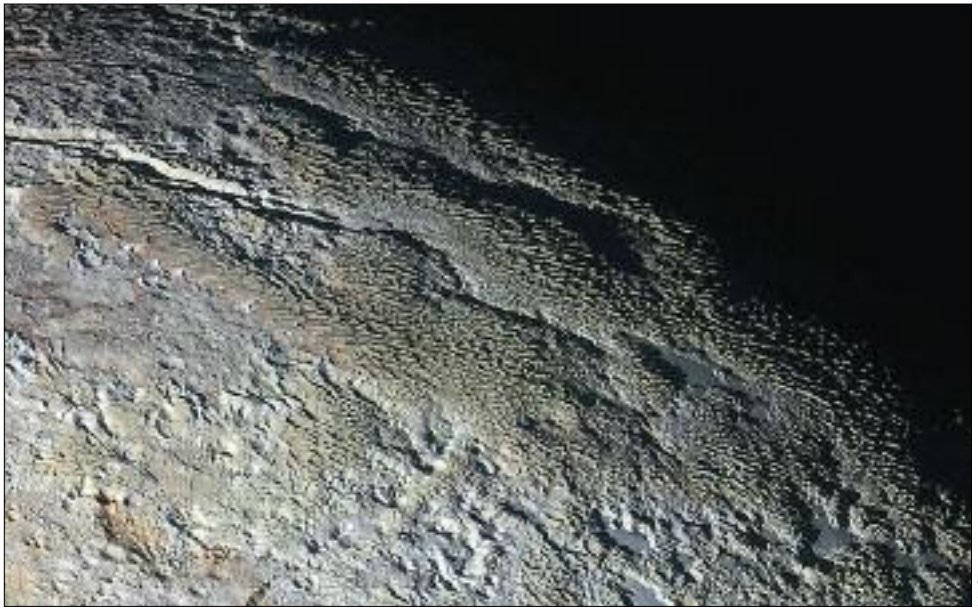
»Terraced« secretions in the shell of an ammonite.

SHUTTERSTOCK

Small terraces on the sea surface churned into foam by the wind.

BOJAN ERHARTIČ

Terrace-like furrowing on the surface of a glacier.



NASA

Terrace-like relief features on Pluto.

MANMADE NONAGRICULTURAL TERRACES AND TERRACED STRUCTURES

Manmade nonagricultural terraces are steps on a slope or built structure that are created by people, are not intended for crops, and mainly have not undergone natural overgrowth. Unlike agricultural terraces, in most cases there was no soil, or it was later removed. People changed the natural landscape by removing layers of slopes, digging into flat ground, and arranging the piled or excess material on the surface. Larger or smaller manmade concave or convex formations of different shapes were created. The terrain was mainly terraced to ensure a means of access to the entire area where people worked, thus also ensuring a means of supervision.

In other cases, such as pyramids, stairways, theaters, stands, terraced gardens, cascades, retaining walls, reservoirs, terraced settlements, terraced apartment buildings, terraced houses, and other terraced structures, people built terraced structures on their own, mostly with stone, concrete, and reinforced concrete.

Manmade terraced landscapes or structures may have a:

- **Settlement role with a mainly residential function**:
- Entire settlements can be terraced; for example, Mediterranean settlements with high urban density on a cliff coast or settlements located on slopes in some dry areas. The rows of houses most often follow the contour lines. The terraces are so narrow that the buildings can only be reached on foot. Wider terraces are characteristic of younger terraced settlements and there is usually enough space for a road along the houses, which ensures access to the houses by car. Sometimes the flat roofs of the lower building rows function as front yards of the houses on the higher rows.
- The rows of houses can also be arranged in steps perpendicular to contour lines. In this case, the roads also cross the contour lines.
- Buildings can also be terraced. Their size varies greatly; sometimes they are only a few stories high, and they can resemble a pyramid or terraced skyscrapers.
- **Transport function**: First, terraced roads or stairways should be mentioned. Their width is related to how monumental and popular a hill or built structure is, their placement in relation to steepness, the stability of the terrain, and the shape and length of the slope, tunnel, or cave. There are straight, zigzag, and spiral stairs, and they can also follow the shape of the terrain. The most interesting stairs lead to various sites of natural or cultural value; for example, temples, monasteries, churches, historical settlements, castles, and tombs. Stairs can be made of sand, stone, wood, brick, or concrete. Terraces with parking areas are more recent, and they arose during the automobile age.
- **Role in exploitation** of natural resources such as minerals or other material from the land's surface in the form of open-pit structures (mines or quarries). In this category there are also terraced salt pans on slopes. These activities are one of the most widespread in terms of human intervention in the Earth's surface (Tarolli and Sofia 2015). Most often, the intervention is connected with a slope because this is the simplest and the least expensive. Eventually the slope line moves inwards on the hill. It is necessary to dig deeper and expand the pit when the minerals are under a relatively flat surface. Widening the pit frequently resembles a downward conical frustum. Waste material gathered while separating the ore can be intentionally deposited, which creates an artificial slope (a pile), which might

DRAGO KLADNIK

In the Peruvian village of Pisac there are historical terraces, which have been restored and play an important role in tourism.

WALLUPNET

A terraced settlement in Iran, where the terraces are simultaneously the roofs of the lower structure and working/leisure areas of the upper one.

◀ The terraced settlement of Positano on the Amalfi Coast in Italy's Campania region. SHUTTERSTOCK

eventually acquire a different role. Terracing takes place in parallel to digging and depositing the material. Terraces are intended for manipulation with machinery, material transportation, and preventing excessive erosion of the bare slopes. In the case of concave or convex formations, terraces are usually created in a spiral form.

- **Communal role**: Cemeteries cover the largest area and are the most common, and less often landfills or warehouses. When there is a lack of flat terrain in a settlement, cemeteries are located on terraced slopes. Many are a well-known and important part of cultural heritage. Usually, specific terraced landfills or warehouses do not endanger the environment.
- **Production or service role**: Sometimes terraces were used for a certain part of craft production. The leather tanneries of Fez, Morocco are a well-known example. Terraces were also used to color, clean, or wash textiles.
- **Role in energy production**: Terraces can be built to increase wind or solar energy efficiency. In such cases, terraces are built to provide space for wind turbines or solar panels. The foundation for solar panels is not necessarily on terraces; however, their step-like arrangement gives them such an appearance.
- **Protective function** in terms of erosion prevention, reinforcing slopes with terraces, or step-like retaining walls. Such terraces may also be connected to transport because terraced slopes or terraced retaining walls are usually built along arterial roads (roads, railways, and canals), and they are also built around tunnel entrances, bridges, and galleries. Terraces protect bedrock against the destructive force of water, snow, ice, wind, flora, and fauna, and thus ensure the safe use of roads or buildings. Their layer of soil is intentionally added and reinforced, and the terrace platforms are generally narrower than usual. Madeira's step-like levadas protect against erosion, and at the same time slow down the flow of irrigation water and make water usage more efficient.
- **Recreational and tourism role**: Residential and tourist areas located in narrow valleys or rugged terrain have well-organized accompanying functions at several levels, such as recreation (ski slopes, playgrounds, and running trails or fitness trails) and tourism (vantage points). Because recreation and tourism have become increasingly popular in the past few decades, these terraces are relatively young.

DRAGO KLADNIK

Terraced salt evaporation pans at Maras in southern Peru are used to obtain salt, which is carried by a stream that flows through a deposit of rock salt.

• **Aesthetic role**: Terraces with aesthetic value are more common than recreation and tourism terraces. These include terraced gardens and cascades of water, which are located in parks and adorn the fronts or backs of castles, mansions, and other monumental buildings, such as museums, galleries, exhibition grounds, and halls. The decorative imitations of natural terraced formations should be mentioned as well.

• **Other roles**: In the remainder of cases, manmade terraces are intended for ritualistic, religious, or spiritual use (the Stations of the Cross, the Holy Stairs, etc.); they can also have a therapeutic role (examples of various kinds of natural radiation, physiotherapy, meditation, or spiritual teachings) or social role (e.g., a meeting point for important men in the village). There are also outdoor and indoor stands in cultural, religious, and sports locations (theatres: arenas, amphitheaters, outdoor cinema, and stadiums) and steps inside pools and reservoirs.

There is also a special group of **historical terraces**. These terraces are preserved because they were first intended for agricultural use, but were afterwards abandoned, and now they can be added to one of these groups. These include archaeological terraces, such as pyramids and amphitheaters. Many such terraces were overgrown and exposed to deterioration, and they needed reconstruction when they were discovered. Examples include the former Incan terraced fields in Peru, Mayan pyramids in southern Mexico, and the Borobudur Buddhist temple in Central Java, Indonesia.

TIM ROBERTS, SHUTTERSTOCK

The terraced rim of a copper mine in Arizona, where the terraces are used for removing excavated ore with trucks.

EWELINA WACHALA, SHUTTERSTOCK

Terraced rows of residential buildings.

SHUTTERSTOCK

A terraced residential building.

SHUTTERSTOCK

A parking lot as an example of traffic terracing.

FLICKR

A terraced cemetery in Hong Kong.

SHUTTERSTOCK

A tailings dump in South Dakota.

MAJA TOPOLE

Terraced irrigation channels on Madeira.

MAJA TOPOLE

Solar cells arranged in a terrace formation in Germany.

FLICKR

Protective terraces along the Panama Canal.

DRAGO KLADNIK

An observation platform with views of the Hani agricultural terraces.

MAJA TOPOLE

The steps on island amidst Lake Bled.

SHUTTERSTOCK

A workshop with terraced dye basins in Fez.

LASZLO SZIRTESI, SHUTTERSTOCK

Artificial pools behind a hotel in Hungary.

KAROL KOZLOWSKI, SHUTTERSTOCK

A terraced pyramid on the island of Tenerife.

SHUTTERSTOCK

Terraced amphitheater seats at Side in Asia Minor.

BOJAN ERHARTIČ

The terraced Temple of Heaven in Beijing.

DRAGO KLADNIK

Deliberation area below the village linden tree in Rut.

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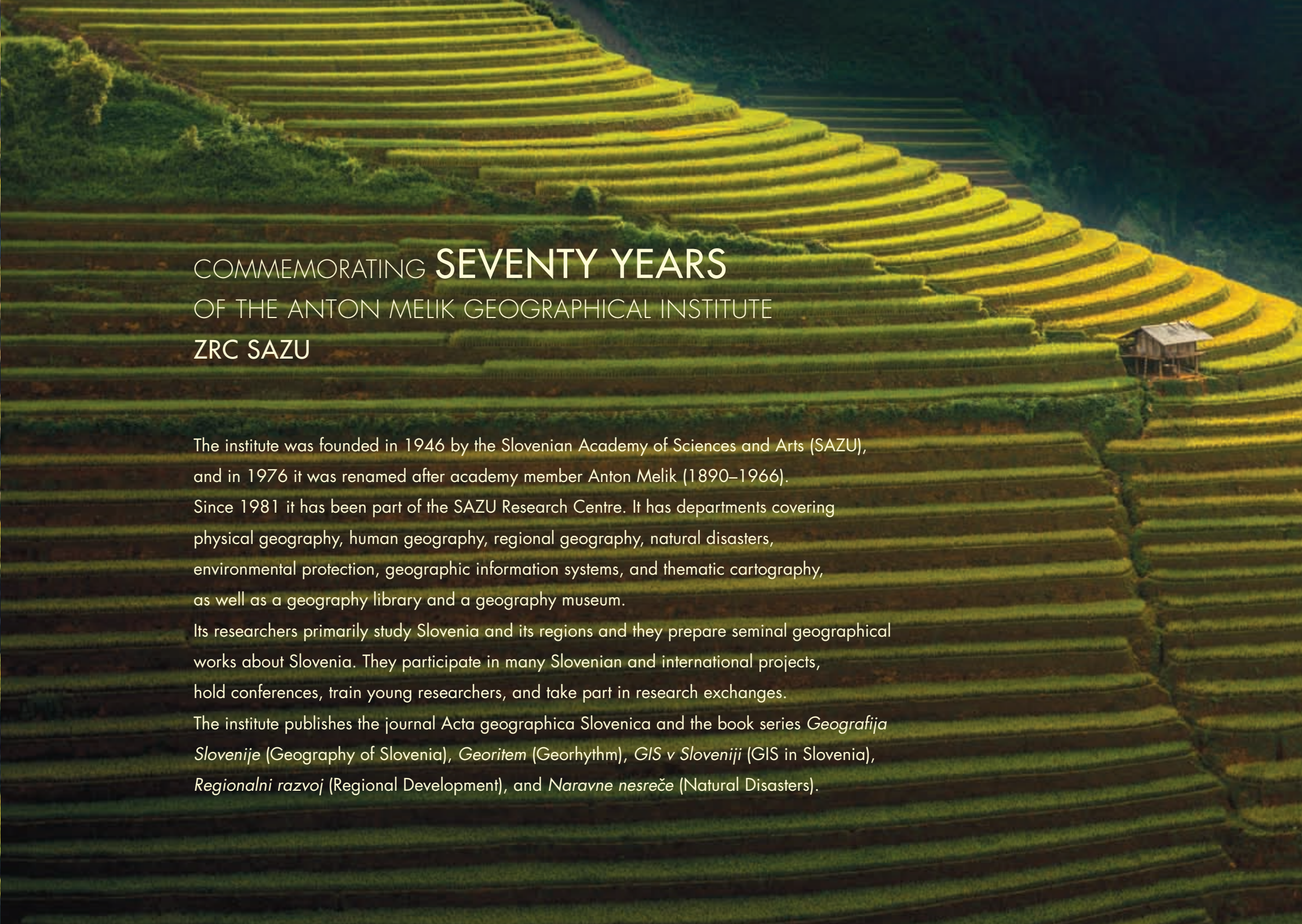

COMMEMORATING SEVENTY YEARS OF THE ANTON MELIK GEOGRAPHICAL INSTITUTE ZRC SAZU

The institute was founded in 1946 by the Slovenian Academy of Sciences and Arts (SAZU), and in 1976 it was renamed after academy member Anton Melik (1890–1966). Since 1981 it has been part of the SAZU Research Centre. It has departments covering physical geography, human geography, regional geography, natural disasters, environmental protection, geographic information systems, and thematic cartography, as well as a geography library and a geography museum.

Its researchers primarily study Slovenia and its regions and they prepare seminal geographical works about Slovenia. They participate in many Slovenian and international projects, hold conferences, train young researchers, and take part in research exchanges.

The institute publishes the journal Acta geographica Slovenica and the book series *Geografija Slovenije* (Geography of Slovenia), *Georitem* (Georhythm), *GIS v Sloveniji* (GIS in Slovenia), *Regionalni razvoj* (Regional Development), and *Naravne nesreče* (Natural Disasters).

TERRACED LANDSCAPES

COMMEMORATING SEVENTY YEARS OF THE ANTON MELIK GEOGRAPHICAL INSTITUTE ZRC SAZU

Terraced landscapes with agricultural terraces are cultural landscapes with a special value. This volume presents them in pictures and words in all their diversity and attractiveness. After discussing the global and European dimensions of terraced landscapes and their agricultural terraces, the volume focuses on Slovenian terraced landscapes; they are discussed separately by landscape types and sample cases in the territory of selected settlements (pilot areas). The conclusion also draws attention to the exceptional value and appeal of non-agricultural terraced landscapes that have been shaped by nature and man.

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