VSAK MILIMETER ŠTEJE

GEODEZIJA NA SLOVENSKEM SKOZI ČAS

EVERY MILLIMETRE COUNTS

GEODESY IN SLOVENIA THROUGH TIME

KAZALO CONTENTS

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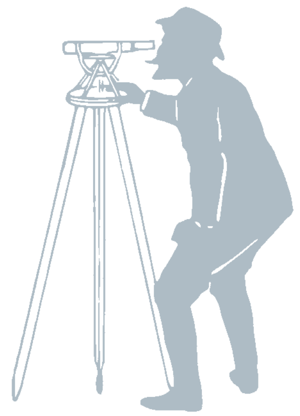


UVODNA BESEDA

Razstava v Depojih državnih muzejev v Pivki leta 2022.
The exhibition in the Depots of the national museums in Pivka, 2022.

Geodetska zbirka Tehniškega muzeja Slovenije je ena od pomembnih zbirk, ki jih hrani muzej. Priča o zgodovini geodezije na Slovenskem od Avstro-Ogrske naprej, med drugim tudi o delu Janeza Vajkarda Valvasorja, ki je povezano s tem področjem in je svojevrstna zanimivost.

Kako se je vse skupaj pravzaprav začelo? Zbirko je leta 1987 zasnovala in postavila Zveza geodetov Slovenije ob sodelovanju Tehniškega muzeja Slovenije. Predstavljala je osrednjo muzejsko predstavitev geodezije in prikazovala razvoj zemljemerstva, geodezije in kartografije na Slovenskem ter v širšem svetovnem okviru od prvih začetkov, rimskega obdobja in srednjega veka prek obdobja nastanka in razvoja zemljiškega katastra do obdobja med vojnama, druge svetovne vojne in še posebej povojnega razvoja. V letu 2006 je bila stalna postavitev dopolnjena s prikazom razvoja geodetske stroke v zadnjih desetletjih 20. stoletja in posodobljena z multimedijsko in interaktivno predstavitvijo, leta 2007 pa obogatena z ambientalnim prikazom zemljemerca v Valvasorjevem času, novo ureditvijo razstavljenih geodetskih instrumentov in panoramsko predstavitvijo širše grajske okolice. Najdragocenejši eksponati iz zbirke so originalne karte in geodetski instrumenti iz 19. in z začetka 20. stoletja.

Pomemben del slovenske geodetske zgodovine predstavlja delo Janeza Vajkarda Valvasorja, ki je od 1672. leta živel in deloval prav na gradu Bogenšperk. Valvasor je bil tudi pomemben topograf in kartograf, ki je že v 17. stoletju proučeval in upodabljal slovensko ozemlje na topografskih slikah in kartah. V njegovem času na Kranjskem ni bilo tiskarskega podjetja, ki bi moglo pripraviti slikovno gradivo za topografska dela, zato je grafično delavnico, bakroreznico in tiskarno ustanovil kar sam. Kakovost Valvasorjevih zbirk topografskih orisov naših krajev in njegovih kart slovenskih pokrajin ni v ničemer zaostajala za evropsko.

S težkim srcem smo geodetsko zbirko Tehniškega muzeja Slovenije, ki je bila na ogled na gradu Bogenšperk, od tam na željo lokalne skupnosti – Javnega zavoda Bogenšperk in občine Šmartno pri Litiji – septembra 2021 umaknili. Nekdanjo postavitev smo dokumentirali in virtualni sprehod po Slovenski geodetski zbirki, kakršna je bila na gradu Bogenšperk, je dostopen na spletni strani TMS.

Ker pa so pogosto pogorišča plodna tla za rojstvo nečesa novega, smo priložnost selitve zbirke izkoristili in se povezali z Geodetsko upravo in Zvezo geodetov Slovenije. Pripravili smo pregledno, privlačno in poučno skupno razstavo, ki je bila od 18. maja do 18. decembra 2022 prvič na ogled v Depojih državnih muzejev v Pivki.

Razstava predstavi kronološki razvoj in pojasni pojme, povezane z geodezijo in kartografijo, prikazuje pa tudi razvoj stroke in glavne mejnike. Sprehodimo se po dvestoletni zgodovini zemljiškega katastra na Slovenskem, posvetimo pa se tudi uporabi geodezije v praksi.

Za razliko od drugih, prepoznavnejših tehniških ved sodi geodezija med temeljne naravoslovne vede in v družini meroslovnih znanosti nosi nesporen pečat izjemne in večplastne aplikativnosti. Temeljno zemljemerstvo je seveda nepogrešljiv instrument in predpogoj prav vseh gradbenih posegov v prostor tako v funkciji nizkih kot visokih gradenj – v preteklosti, celo v davnini, in tudi danes. Človek je od vekomaj osvajal prostor, ki ga je potreboval in mu je bil na voljo. Ne glede na to, ali je gradil bivalne objekte, transportno komunikacijske sisteme, reguliral naravne habitate ali kaj drugega. Prav vse je moral načrtovati in geodezija je bila pri tem nepogrešljivo orodje.

Pomemben in za širše občinstvo zanimiv del prikazuje geodezijo v praksi. V našem vsakdanu jo najdemo v povezavi z inženirstvom, pri gradnjah, izmerah, daljinskem zaznavanju, v kmetijstvu, raziskovanju in proučevanju kulturne dediščine in nenazadnje tudi v vojski. Slednje smo vsebinsko povezali s Parkom vojaške zgodovine, v katerem se nahajajo Depoji državnih muzejev (Tehniškega muzeja Slovenije, Narodnega muzeja Slovenije in Muzeja novejše zgodovine Slovenije) in na razstavi predstavi svoj eksponat. S tem želimo poudariti pomen sodelovanja med sorodnimi in drugimi institucijami.

Za približevanje geodezije in strokovnega izrazja smo oblikovali pojmovnik, ki z zanimivimi ilustracijami nagovori tudi manj posvečene obiskovalce.

Pri vedi, kot je geodezija, si ne moremo kaj, da ne bi usmerili pogleda v prihodnost, kjer znanost in razvoj dajeta slutiti, da se bodo npr. satelitski sistemi, razviti v geodeziji, širili naprej v vesolje, meje pa si bomo primorani postavljati sami. Tudi zaradi vprašanja ekologije in skrbi za okolje.

Namen priložnostne razstave je, da razmeroma neznano in morda spregledano ali slabo poznano tehnično vedo približamo širši javnosti, vzbudimo zanimanje zanjo, pokažemo, kje vse v našem vsakdanu najdemo elemente geodezije, in hkrati poudarimo našo dediščino na tem pomembnem področju.

V Tehniškem muzeju Slovenije v luči prihodnje celostne prenove samostansko-grajskega kompleksa v Bistri pripravljamo tudi idejno zasnovo vsebinske prenove zbirk. V novo, sodobno postavitev bomo vključili tudi geodetsko tematiko, ki bo tako predstavljena v novem kontekstu in prenovljenem razstavnem prostoru.

Lepo vabljeni!

dr. Barbara Juršič
direktorica Tehniškega muzeja Slovenije

INTRODUCTION

The Slovene Geodetic Collection of the Technical Museum of Slovenia is one of the essential collections held by the museum. It bears witness to the history of geodesy in Slovenia from the Austro-Hungarian Empire onwards, including the work of Janez Vajkard Valvasor, which is related to this field and is a curiosity of its own.

How did it all start? The collection was conceived and set up in 1987 by the Association of Surveyors of Slovenia in cooperation with the Technical Museum of Slovenia. It was the central museum presentation of geodetic engineering, displaying the development of land surveying, geodesy and cartography in Slovenia and worldwide from the beginnings, the Roman period and the Middle Ages, through the period of the establishment and development of the land cadastre, to the interwar period, World War Two and the post-war development. In 2006, the permanent exhibition was added a presentation of the development of the surveying profession in the last decades of the 20th century and updated with a multimedia and interactive presentation, followed in 2007 by an ambient presentation of a land surveyor in Valvasor's time, a rearrangement of the surveying instruments and a panoramic representation of the castle surroundings. The most valuable exhibits in the collection include original maps and surveying instruments from the 19th and early 20th centuries.

A significant part of Slovene geodetic history is the work of Janez Vajkard Valvasor, who lived and worked at Bogenšperk Castle from 1672. Among other things, Valvasor was also an eminent topographer and cartographer who, as early as the 17th century, studied and depicted the Slovene territory in topographical pictures and maps. In his time, there wasn't a workshop in Carniola able to produce images for his publications, so Valvasor set up a graphics workshop – the copperplate engraving and printing works – in his home. His topographical collections and maps of his native land put Valvasor alongside the most accomplished scientist of his time.

With a heavy heart, the Technical Museum of Slovenia removed the geodetic collection, exhibited at Bogenšperk Castle, from the location in September 2021 at the request of the municipality of Šmartno pri Litiji and the Bogenšperk Public Institute. We have documented the exhibition, and a virtual tour of the collection as displayed at Bogenšperk Castle is available on the TMS website.

However, as ruins are often fertile ground for the birth of something new, we took the opportunity and partnered with the Surveying and Mapping Authority of the Republic of Slovenia and the Association of Surveyors of Slovenia and put on a comprehensive, attractive, and informative joint exhibition, which was on display from 18 May until 18 December 2022 at Pivka depots of national museums.

The exhibition presents chronological development and explains the concepts related to surveying and cartography, the evolution of the profession, and the main milestones. We walk through the two-hundred-year history of the land cadastre in Slovenia and introduce the practical applications of geodetic engineering.

Unlike other, more recognisable engineering sciences, geodesy is one of the fundamental natural sciences characterised by a wide range and multifaceted applicability among metrological sciences. Land surveying is an indispensable instrument and a prerequisite for all civil engineering developments, both in low-rise and high-rise construction – in the past, way back in antiquity, and today. Since time immemorial, man has always conquered the space he needed and was available to him. Whether building residential structures, transport and communication systems, regulating natural habitats, or else. He had to plan everything, and surveying was an indispensable tool.

An important and attractive part of the exhibition shows applications of geodetic engineering in practice. In our everyday lives, we find it in relation to mechanical engineering, construction, measurements, remote sensing, agriculture, research and study of cultural heritage, and, last but not least, in the military. The latter has been associated with the Park of Military History, which houses the Depots of the national museums (Technical, National, and Museum of Contemporary History) and is participating in the exhibition to underline the importance of collaboration between related and other institutions.

So that our visitors learn more about surveying and its terminology, we had designed a glossary that appeals to less knowledgeable visitors with exciting illustrations.

In a discipline such as geodetic engineering, we cannot help but look to the future, where science and development suggest that, for example, satellite systems developed in surveying will spread further into space, and we will be compelled to set boundaries, also due to the ecological issues and environmental concerns.

The objective of this temporary exhibition is to bring a relatively unknown and perhaps overlooked or little-known technical discipline to the attention of the general public, to spark interest in it, to show where elements of surveying can be found in our everyday lives, and at the same time to address our heritage in this vital field.

The Technical Museum of Slovenia is working on a new conceptual design for its collections in light of the future comprehensive renovation of the monastery and castle complex in Bistra. The modern design will also include geodetic engineering displayed in a new context and a renovated exhibition space.

You are most welcome!

Barbara Juršič, Ph.D.
Technical Museum of Slovenia, Director

UVODNE MISLI

Naloge državne geodetske službe v Sloveniji izvaja Geodetska uprava RS. Temeljna področja delovanja tradicionalno vključujejo osnovni geodetski sistem, evidentiranje in vrednotenje nepremičnin, izvajanje postopkov zemljiške administracije in preurejanja zemljišč ter dejavnosti na področju zagotavljanja referenčnih prostorskih podatkov, kot so temeljni topografski podatki, podatki prostorskih enot, zemljepisna imena in drugi podatki o prostoru in nepremičninah. Poslanstvo Geodetske uprave RS je zagotoviti kakovostno uradno prostorsko podatkovno infrastrukturo ter sistem zemljiške administracije, uporabnikom pa učinkovite storitve in kakovostne uradne prostorske podatke na načine, ki ustrezajo visokim standardom geoinformacijsko usposobljene sodobne družbe.

Za razvoj slovenske geodetske stroke so posebej pomembni dogodki, ki so se zgodili pred dvesto leti v takratni Avstro-Ogrski monarhiji. V zelo kratkem obdobju smo dobili podlage za poznejši zemljiški kataster, ki nam v dobršni meri služijo še danes. Za začetek sodobnega evidentiranja nepremičnin na našem ozemlju velja cesarski patent Franca I. z dne 23. 12. 1817, s katerim je ukazal izvedbo stabilnega katastra v avstrijskih deželah. Takrat ustanovljena deželna komisija za regulacijo zemljiškega davka je pomenila predhodnico današnje geodetske uprave. Kot ustanovni datum državne geodetske službe v novejši zgodovini sicer štejemo 20. januar 1944, ko je bila med NOB z odredbo Glavnega štaba NOV in PO Slovenije ustanovljena Geodetska sekcija. Sekcija je bila zadolžena za oskrbo štabov z vojaškim topografskim gradivom ter pripravo in izdelavo novih kart. Geodetska uprava pri Vladi Ljudske republike Slovenije je bila z uredbo ustanovljena 26. 3. 1947.

Državna geodetska služba v Sloveniji ima torej pestro in dolgo zgodovino. Znana je trditev, da se iz zgodovine učimo in to velja tudi za geodetsko stroko. Veliko tega, kar ima danes človeštvo, je pravzaprav podedovano in je nastalo na podlagi spoštovanja zgodovinskih izkušenj. Zato moramo to ceniti in predstaviti širši strokovni in laični javnosti na pravi način. Geodetska uprava Republike Slovenije se skupaj z drugimi deležniki geodetske stroke zaveda pomena ohranjanja starih načrtov, arhivskih letalskih posnetkov oziroma celotnih arhivskih elaboratov izmere in njihove pretvorbe v digitalno obliko. Preteklost in zgodovino stroke moramo pravilno umestiti v zgodovinsko in kulturno dediščino.

Nekateri naši kolegi so to znali izvesti pred desetletji. Leta 1982 je bilo postavljeno spominsko obeležje Geometričnega središča Slovenije (GEOSS) na območju Spodnje Slivne pri Vačah v občini Litija. Pet let kasneje smo dobili Slovensko geodetsko zbirko na gradu Bogenšperk, ki je vse do oktobra 2021 predstavljala osrednjo muzejsko predstavitev naše stroke na Slovenskem. In pred 25 leti je bilo na Krimu postavljeno obeležje Koordinatnega izhodišča prve katastrske izmere na območju sedanje Slovenije. Omenim naj še monografijo *Geodetski instrumenti na Slovenskem* avtorjev Janeza Slaka in Boštjana Puclja. Njen izid konec leta 2017 ob dvestoletnici začetka nastajanja zemljiškega katastra je pospremila tudi razstava starih geodetskih instrumentov in opreme na Slovenskem, ki je zaokrožila po domačih muzejih in razstavnih prostorih. Pristopili smo k aktivnostim, s katerimi želimo postaviti izhodišča za vključitev določenih geodetskih točk v tehnično in kulturno dediščino in opredeliti obveznosti za njihovo vzdrževanje. S Fakulteto za gradbeništvo in geodezijo sodelujemo tudi pri pobudi avstrijskih kolegov za uvrstitev določenih geodetskih znakov na Unescov seznam kulturne dediščine. Pričujoči vodnik po razstavi z naslovom *Vsak milimeter šteje* je še en pomemben drobec v mozaiku upravljanja z obsežnim katastrskim operatom in promoviranja bogate tehnične kulturne dediščine v Sloveniji.

Seveda pa je glavnina našega dela obrnjena v prihodnost in lahko bi rekli, da Geodetska uprava RS skrbi za pripravo in vzpostavitev prihodnjih spomenikov geodetske dejavnosti. Z izvedbo vsakoletnega programa del državne geodetske službe in z izvajanjem posameznih projektov nastajajo nove oziroma se izboljšujejo obstoječe evidence. V letu 2022 zaključujemo obsežen program projektov eProstor, financiran iz evropskih kohezijskih sredstev, v okviru katerega smo izboljšali procese pri prostorskem načrtovanju, graditvi objektov in upravljanju z nepremičninami, kar je bilo mogoče doseči s povezljivimi, enostavno dostopnimi in zanesljivimi zbirkami prostorskih podatkov. Eden temeljnih ciljev eProstora je bila tudi informacijska prenova nepremičninskih evidenc. Prvič po letu 1882 smo digitalizirali vse elaborate katastrskih meritev in se v celoti usmerili v elektronsko poslovanje. Z digitaliziranim katastrom nepremičnin in izboljšanim grafičnim prikazom bo vnos sprememb podatkov (o parcelah, stavbah, prostorskih enotah in državni meji) preprostejši, natančnejši in hitrejši. V postopkih pridobitve gradbenega dovoljenja, priprave prostorskih aktov in evidentiranja nepremičnin bo omogočeno elektronsko poslovanje. Izvedena bo lokacijska izboljšava grafičnega dela zemljiškega katastra in zajeti podatki o pozidanih stavbnih zemljiščih.

Podatki in storitve Geodetske uprave RS niso pomembni samo za številne institucije državne in lokalne javne uprave, temveč tudi za uresničevanje strateških ciljev države. Pomembno področje delovanja predstavlja sodelovanje z različnimi javnimi institucijami, ki uporabljajo ali soustvarjajo rešitve na področjih prostorske podatkovne infrastrukture in zemljiške administracije. Zato je prav, da poskrbimo za ohranjanje naše skupne bogate tehnične in kulturne dediščine. Priložnostna razstava in vodnik po njej sta zgolj korak na tej poti, vendar brez tovrstnih korakov nikoli ne bomo dosegli cilja.

Tomaž Petek
Generalni direktor Geodetske uprave Republike Slovenije

PROLOGUE

The Surveying and Mapping Authority of the Republic of Slovenia (SMA) is responsible for the tasks of the state geodetic service, which include basic geodetic system, real estate registration, mass real estate valuation, administrative procedures related to the registration of changes in physical space and real estate, maintenance of national reference system which provides topographic data on natural and constructed environment, geographical names and other records data on environment and real estate. SMA's mission is to ensure high-quality official spatial data infrastructure and real estate administration system and provide clients with adequate services and high-quality official spatial data in compliance with the high standards of contemporary geoinformation society.

Events that took place two hundred years ago in the then-Austro-Hungarian Monarchy are significant for developing the Slovene surveying profession. In a brief period, we obtained the foundations for the subsequent land cadastre, which to a considerable extent, still serve us today. The beginning of modern land registration on our territory is the patent issued by Francis I on 23 December 1817, ordering the establishment of a stable land cadastral system in the Austrian lands. The commission for the assessment of land tax was the forerunner of today's surveying and mapping authority. The founding date of the National State Surveying Authority in recent history is generally considered to be 20 January 1944, when the general staff of the National Liberation Army and the Partisan Committee of Slovenia issued a decree on establishing a Surveying Section. Initially, its task was to supply command structures with military topographic data and draft and produce new maps. The Surveying and Mapping Authority of the Government of the People's Republic of Slovenia was founded by a decree dated 26 March 1947.

The Authority has a long and exciting past. A well-known saying goes that history is our teacher, which definitely holds for the surveying profession. Much of humankind's current assets were inherited and built by respecting the lessons drawn from history. We must appreciate and adequately present the past to the broader public. The Authority and other stakeholders in the surveying profession fully understand the importance of preserving old plans, archival aerial photographs and entire archival reports and their conversion to a digital format. The history of our work must be positioned accordingly as part of our historical and cultural heritage.

Some of our colleagues embarked on this journey decades ago. In 1982, a memorial stone marking the Geometric Centre of Slovenia (GEOSS) was erected in the Spodnja Slivna near Vače in the Litija Municipality. Five years later, the Slovene Geodetic Collection was opened at Bogenšperk Castle and, until October 2021, presented the central national exhibition of our profession. Twenty-five years ago, a memorial marking the coordinates of the first cadastral survey in present-day Slovenia was placed on Krim. I would also like to mention a 2017 monograph, Surveying Instruments and Equipment in Slovenian Lands, by Janez Slak and Boštjan Pucelj, published to honour the bicentenary of the beginning of the land cadastre creation in our country. It was accompanied by an exhibition of old surveying instruments and equipment touring Slovenia. We have engaged in activities for the inclusion of some survey points in the cultural heritage and defining the requirements for their maintenance. In addition, we have joined forces with the Faculty of Civil and Geodetic Engineering to take part in the initiative of our Austrian colleagues to place several survey marks on the UNESCO List of Cultural Heritage. The guide to the exhibition Every Millimetre Counts is another critical piece in managing largescale cadastral records and promoting Slovenia's rich cultural and technical heritage.

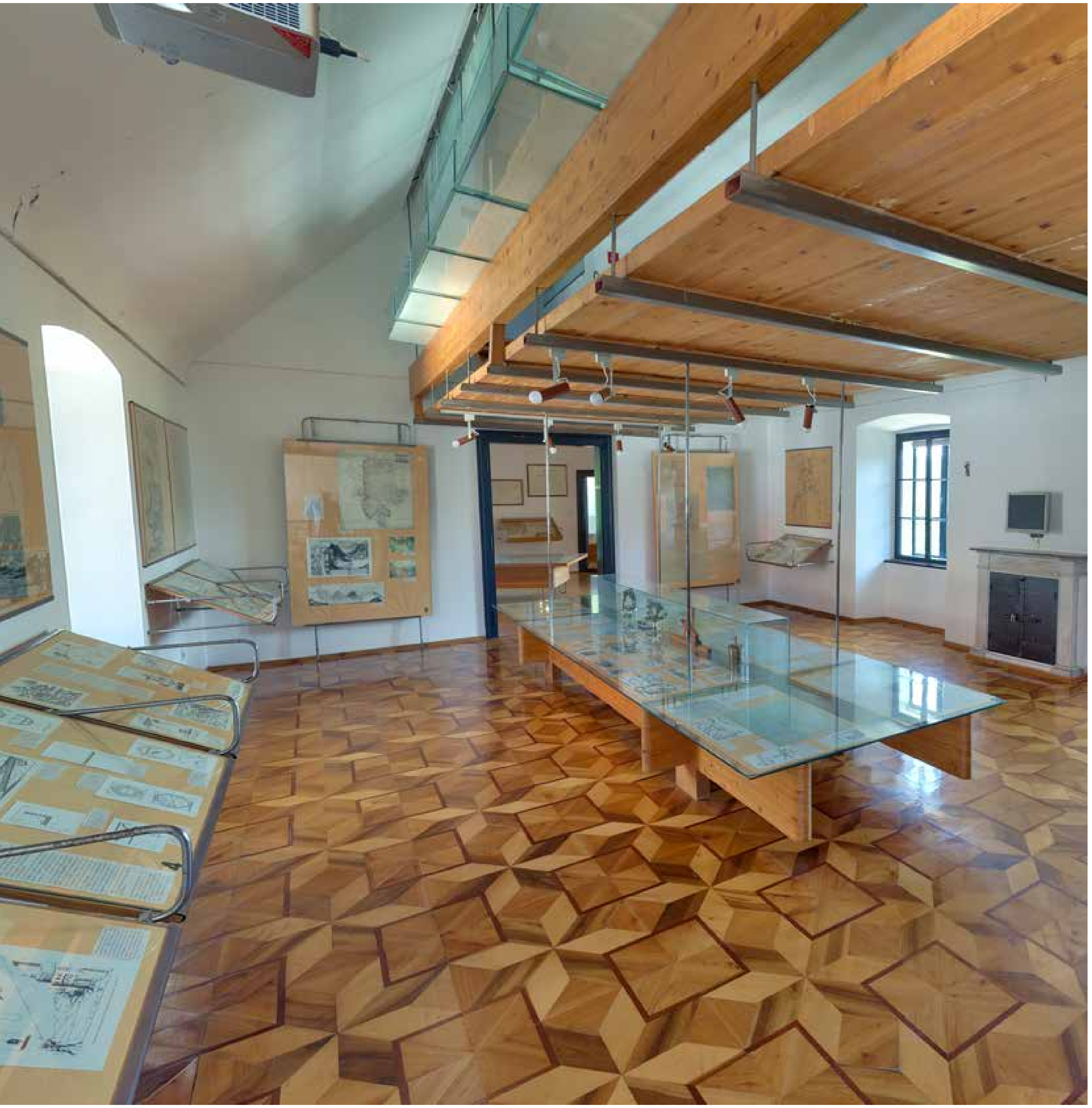
However, the majority of our activities are oriented to the future. We might say that the Authority is responsible for preparing and establishing »future monuments« to surveying. Through its annual activities, including the implementation of individual projects, the Authority continues to create new or improve existing records. In 2022, we are completing a large-scale programme of eProstor projects funded by the EU's Cohesion Fund. The programme's outcome is the improvement of processes in spatial planning, construction of facilities and real estate management, which was accomplished through connected, easily accessible and reliable spatial data records. One of eProstor's main objectives was an information overhaul of real estate records resulting in the digitization of all reports and a switch-over to online services and procedures. Digitized real estate register and the improved graphical display will allow easier, more accurate and faster entry of changes to the records (on land plots, buildings, spatial units and the national border). The interested parties will be provided with online procedures for obtaining a construction permit, drafting spatial planning documents and registering real estate. The positional accuracy of the land cadastre's graphical data will be improved and data on built-up building land will be acquired.

Besides being essential for many state and local public administration institutions, the records and services provided by the RS Surveying and Mapping Authority also play a significant role in implementing national strategic objectives. Cooperation with various public institutions that use or co-develop solutions in spatial data infrastructure and land administration thus presents an important area of activity. Preserving our nation's rich technical and cultural heritage is the right thing to do. This temporary exhibition and its guide are only a step in this direction. However, such efforts are vital to completing the path.

Tomaž Petek
Surveying and Mapping Authority of the Republic of Slovenia, Director- General

Slovenska geodetska zbirka na gradu Bogenšperk v letih od 1987 do 2021, osrednji del.

 Slovene Geodetic Collection at Bogenšperk Castle between 1987 and 2021, central part.



1 SLOVENSKA GEODETSKA ZBIRKA: 1987–2021 IN KAKO NAPREJ

Slovenska geodetska zbirka je bila več kot tri desetletja na ogled obiskovalcem gradu Bogenšperk. V tem času je bila to osrednja muzejska predstavitev geodezije na Slovenskem.

Zbirko je leta 1987 zasnovala in vzpostavila Zveza geodetov Slovenije ob sodelovanju Tehniškega muzeja Slovenije. Po sporazumu med ZGS in TMS je zbirka ob odprtju 18. 9. 1987 postala oddelek TMS z imenom Slovenska geodetska zbirka Tehniškega muzeja Slovenije. V celoti je bila rezultat prostovoljnega dela brez stalnih finančnih virov. Nastajala je pet let. Za zasnovo in organizacijo je skrbel Peter Svetik, vsebino z opisi eksponatov pa je v glavnem prispeval Branko Korošec, s čimer je povzel in nadgradil svojo monografsko publikacijo *Naš prostor v času in projekciji* (1978). Umestitev v prostor gradu Bogenšperk in oblikovanje razstave sta bila delo arhitekta Otona Jugovca. Postavitev zbirke je bila financirana s prostovoljnimi prispevki ustanov in podjetij s področja geodezije, Republiške Geodetske uprave in občinskih geodetskih uprav. Zbirko sta finančno podprli tudi FAGG Oddelek za geodezijo ter Vojaški geografski institut iz Beograda, pa tudi številne ustanove izven geodezije, med njimi, prek Tehniškega muzeja Slovenije, tudi Kulturna skupnost Slovenije (predhodnica današnjega Ministrstva za kulturo).

Pomemben del slovenske geodetske zgodovine predstavlja delo Janeza Vajkarda Valvasorja. Valvasor je bil namreč med drugim pomemben topograf in kartograf, ki je že pred več kot tristo leti preučeval in upodabljal slovensko ozemlje. Valvasorjeve zbirke topografskih orisov slovenskih krajev in njegove karte naših pokrajin – izdeloval jih je večinoma na gradu Bogenšperk – so po kakovosti dosegale evropsko raven.

Geodetski zbirki so bili na gradu namenjeni trije prostori v drugem nadstropju južne strani in poseben preurejen hodnik – viseča galerija na podstrešju, ki vodi v razgledni stolp. Zbirka je bila urejena kronološko in je prikazovala razvoj zemljemerstva, geodezije in kartografije na Slovenskem in v svetu od prvih začetkov, prek rimskega obdobja in srednjega veka, obdobja nastanka in razvoja zemljiškega katastra do obdobja med vojnama, druge svetovne vojne in še posebej povojnega razvoja.

V letu 2006 je bila stalna postavitev dopolnjena s prikazom razvoja geodetske stroke zadnjih desetletij 20. stoletja in posodobljena z multimedijsko in interaktivno računalniško predstavitvijo. Leta 2007 je bila zbirka obogatena še z ambientalnim prikazom zemljemerca v Valvasorjevem času, z novo ureditvijo razstavljenih geodetskih instrumentov in panoramsko predstavitvijo širše grajske okolice. Na 120 m² je bilo razstavljenih nad 400 eksponatov, največ je bilo reprodukcij, najdragocenejši eksponati pa so bile originalne karte in geodetski instrumenti iz 19. in začetka 20. stoletja. Pri prenovi so sodelovali Geodetska uprava RS, Geodetski inštitut Slovenije, Tehniški muzej Slovenije ter Javni zavod Bogenšperk.

15. septembra 2021 je stalna postavitev zbirke na gradu Bogenšperk za obiskovalce zaprla svoja vrata in Tehniški muzej Slovenije je 24. septembra z gradu odpeljal še zadnje eksponate in zbirko deponiral.

Občina Šmartno pri Litiji kot lastnik in Javni zavod Bogenšperk kot upravitelj gradu sta zaradi reorganizacije zavoda zbirki odrekla nadaljnje gostoljubje. Prenovljen načrt razvoja gradu Bogenšperk ter prenova objekta z drugačno vsebino po letu 2021 ni več vključevala geodetske zbirke v takšnem obsegu. Pomemben vzrok za to je bila tudi zastarelost muzejske predstavitve in posledično vse manjše zanimanje obiskovalcev gradu zanjo.

Tako je zbirka ostala brez razstavnega prostora, za katerega je bila v osemdesetih letih 20. stoletja na povabilo Odbora za obnovo gradu Bogenšperk tudi namensko zasnovana v tedaj obnovljenih, a praznih grajskih prostorih. Tehniški muzej Slovenije jo je bil kot lastnik, v sodelovanju s partnerji iz geodetske stroke (Zvezo geodetov Slovenije in Geodetsko upravo RS), primoran umakniti z gradu v upanju, da se ji čim prej najde nove razstavne prostore ter jo v sodobni vsebinski in muzeološki predstavitvi znova ponudi na ogled obiskovalcem.

Geodetska uprava RS je zato skupaj z Zvezo geodetov Slovenije in Oddelkom za geodezijo Fakultete za gradbeništvo in geodezijo UL oblikovala delovno skupino za pripravo načrta aktivnosti in ukrepov za prenovo geodetske zbirke. Pri delu skupine sodeluje tudi Tehniški muzej Slovenije, ki je ponudil možnost priprave občasne razstave v letu 2022 v oglednem delu Državnih depojev v Pivki.

Delovna skupina v sestavi dr. Dušan Kogoj, mag. Martina Orehovec, Mateja Urbančič, Boštjan Pucelj, Tomaž Šuštar in mag. Janez Slak je bila postavljena pred dejstvo, da so nam geodetsko zbirko iz Bogenšperka pregnale čarovnice v dobesednem pomenu besede (v prostore nekdanje zbirke namerava lastnik gradu umestiti čarovništvo na Slovenskem). Ne glede na to, da so po Valvasorju coprnice krive za številne stvari, ne pa tudi izgon zbirk kulturne dediščine in da je že Marija Terezija prepovedala »lov na čarovnice«, je »hudič« na gradu Bogenšperk še poslednjič udaril z repom in s pomočjo coprnic odnesel zbirko ne na Klek, temveč v Pivko, in jo skril v depoje.

Delovna skupina je iskala najprej kratkoročno prebroditev nastale situacije, in sicer kako promovirati geodetsko stroko v času do postavitve nove zbirke v primernih prostorih, v nadaljevanju pa se bo lotila aktivnih priprav na posodobitev prihodnje geodetske zbirke, upoštevaje pravila muzealske stroke in primere dobrih praks.

Prva naloga skupine je bila priprava nove občasne razstave s pomenljivim naslovom *Vsak milimeter šteje*, ki govori o geodeziji na Slovenskem skozi čas. Razstava je bila od 18. maja do 18. decembra 2022 na ogled v Depojih državnih muzejev v Pivki, potem pa so sledila gostovanja: od 15. februarja do 12. junija 2023 na Oddelku za geodezijo Fakultete za gradbeništvo in geodezijo UL, od 15. junija do 30. septembra 2023 je bila dopolnjena razstava na ogled na gradu Sevnica, konec leta pa v Kulturnem domu v Gorici, Italija.

Razstava *Vsak milimeter šteje* vsebuje 31 panojev, ki predstavljajo zgodovino geodetske stroke, metode merjenja, kartografijo, zemljiški kataster, geodezijo in suverenost države, znanost ter razvoj in primere geodetske stroke v praksi. V prostorih stopnišča Državnih depojev v Pivki je bilo razstavljenih devet geodetskih instrumentov za določanje koordinat (teodolit, tahimeter, elektrooptični razdaljemer in GPS sprejemnik), pet nivelirjev (instrument za določanje višinskih razlik) in nekaj nepogrešljivih geodetskih pripomočkov (merski trak, orodje za grafično določanje površin, kartirni aparat, triroba prizma ...). V posebni vitrini je bil prikazan katastrski načrt iz leta 1824 z vrisanimi spremembami v prvih 150 letih. Priložena so bila geodetska orodja, ki so se uporabljala v omenjenem obdobju za vzdrževanje katastrskih načrtov (polarni koordinatograf, nitni planimeter, nanašalni trikotniki, logaritmično računalo, pisalni in risarski pribor).

Končno podobo bo Slovenska geodetska zbirka dobila šele, ko bodo zanjo zagotovljeni ustrezni prostori. Trenutno se zdi najbolj optimalna umestitev v okviru ostalih zbirk TMS v Bistri pri Vrhniki, saj je muzej v začetni fazi gradbene in vsebinske prenove.

mag. Martina Orehovec, mag. Janez Slak

1 SLOVENE GEODETIC COLLECTION: 1987-2021 AND WHAT NEXT

For over three decades, the Slovene Geodetic Collection (Cartographic Collection) was displayed for visitors to Bogenšperk Castle. Over this period, it was the central national exhibition on surveying and related fields.

The Association of Surveyors of Slovenia designed and put on the collection in collaboration with the Technical Museum of Slovenia (TMS) in 1987. As agreed by both parties, upon its opening on 18 September 1987, it became a department of TMS called the Slovene Geodetic (Cartographic) Collection of the Technical Museum of Slovenia. Five years in the making, the collection resulted from a voluntary effort without any permanent funding. The design and organisation were the work of Peter Svetik, while the content, with descriptions of the exhibits, was mainly contributed by Branko Korošec, who took up and expanded on his publication *Naš prostor v času in projekciji* (1978) on the development of land surveying, cartography and spatial planning in central Slovenia. The exhibition's placement in the Bogenšperk Castle setting and its design were in the hands of the architect Oton Jugovec. The set up of the collection was funded by voluntary contributions from institutions and companies in the field of surveying, the national and regional Surveying and Mapping Authorities, the Faculty of Architecture, Civil and Geodetic Engineering, Dept. of Geodetic Engineering, Military Geographical Institute from Belgrade as well as many non-surveying institutions, including, through the Technical Museum of Slovenia, the Cultural Association of Slovenia (the predecessor of today's Ministry of Culture).

Janez Vajkard Valvasor made a vital contribution to Slovene geodetic history. He was, among other things, a topographer and cartographer who studied and depicted the territory of modern-day Slovenia more than three hundred years ago. Valvasor's topographical collections of Slovene settlements and his maps of ethnic Slovene lands – most of which he produced at Bogenšperk Castle – were of a quality that met the highest standards of the time.

The Geodetic Collection encompassed three rooms on the second floor of the castle's south wing, together with a refurbished attic gallery leading to the lookout tower. It was arranged in chronological order and presented the development of surveying, geodesy and cartography locally and in the world from its very beginnings, through the Roman period and Middle Ages, the establishment and evolution of land cadastre to the 20th century, including the interwar period, World War Two and particularly the post-war development.

In 2006, the permanent exhibition was supplemented with a presentation of the development of the surveying profession in the last decades of the 20th century and updated with multimedia and interactive presentation. In 2007, the collection was further enriched with an ambient representation of a surveyor in Valvasor's time, a new disposition of the surveying instruments, and a panoramic presentation of the castle's surroundings. Most of the more than 400 exhibits displayed on 120 m^2 were reproductions; however, the collection also included several valuable objects, such as the original maps and surveying instruments from the 19th and early 20th centuries. The partners participating in the renovation included the Surveying and Mapping Authority of the Republic of Slovenia, the Geodetic Institute of Slovenia, the Technical Museum of Slovenia and the Bogenšperk Public Institute.

On 15 September 2021, the permanent exhibition at Bogenšperk Castle closed its doors to visitors. On 24 September, the Technical Museum of Slovenia took the last exhibits from the castle and transferred the collection to a depo.

As the owner, the municipality of Šmartno pri Litiji, and the Bogenšperk Public Institute, as the castle administrator, denied the collection hospitality due to the reorganisation. In its existing form, the collection no longer fitted the revised development plan for Bogenšperk Castle and the renovation of the building, which anticipated new programmes for visitors post-2021. An important reason was the obsolete presentation and the consequent declining interest of visitors.

This left the collection without the exhibition space, for which it had been purposely designed in the 1980s, at the invitation of the Bogenšperk Castle Restoration Committee, in the then-restored but empty castle premises. The Technical Museum of Slovenia, as the owner, in collaboration with partners from the surveying profession (the Association of Surveyors of Slovenia and the Surveying and Mapping Authority of the Republic of Slovenia), was compelled to remove it from the castle, hoping to find a new place as soon as possible and reintroduce it to visitors in a modern contextual and museum presentation.

To this end, the Surveying and Mapping Authority of RS, together with the Association of Surveyors of Slovenia and the Department of Geodetic Engineering at the Faculty of Civil and Geodetic Engineering, University of Ljubljana, formed a working group to prepare a plan of activities and actions for the renovation of the geodetic collection. As the group participant the Technical Museum of Slovenia offered to organise a temporary exhibition in 2022 at the Depots of the national museums in Pivka.

The working group, composed of Dušan Kogoj, Ph.D., Martina Orehovec, MA, Mateja Urbančič, Boštjan Pucelj, Tomaž Šuštar and Janez Slak, M.Sc., had to deal with the fact that the geodetic collection had been driven away from at Bogenšperk by witches in the literal sense of the word (indeed, the rooms of the former collection will host witchcraft in Slovenia). Regardless of that, according to Valvasor, the witches are guilty of many things – but definitely not the expulsion of cultural heritage collections – and that it has been centuries since Maria Theresa banned „witch hunts," the „devil" struck one last blow at Bogenšperk Castle and, assisted by witches, took the collection not to Klek but to Pivka, hiding it in the depots.

The working group first sought a short-term solution, namely, how to promote the surveying profession in the period leading up to the new exhibition in suitable premises, and then to actively work on the modernisation of the geodetic collection, following professional guidelines and examples of good practice.

The group's first objective was to put on a new temporary exhibition with a compelling title, Every Millimetre Counts, dedicated to geodesy in Slovenia through time. It was displayed for a year at the Depots of state museums in the Park of Military History in Pivka. Afterward, it went on a tour accross Slovenia: from 15th February until 12th June 2023 at The Department of Geodetic Engineering, Faculty of Civil and Geodetic Engineering, University of Ljubljana; from 15th June until 30th Septembre 2023 the exhibition with additions was on a display at Sevnica castle, and at the end of the year at the Culture Center in Gorica, Italy.

The exhibition Every Millimetre Counts includes 31 panels introducing the history of the surveying profession, measurement methods, cartography, land cadastre, geodesy and national sovereignty, science and the development and practical applications of geodetic engineering. In the staircase of the Depots of national museums in Pivka, nine surveying instruments for measuring horizontal and vertical angles (theodolite, tacheometer-theodolite, optical distance meter and GPS receiver), five levels (instruments for determining heights) and some indispensable surveying instruments (measuring tape, instruments used in mapping and area calculation, triangular prism, etc.) were exhibited. In a separate display case, the cadastral map of 1824 was shown, with changes made in the first 150 years plotted. The surveying tools used during the period to maintain cadastral maps (circular protractor, thread planimeter, precision compasses, slide rule, writing and drawing instruments) were also exhibited.

The Slovene Geodetic Collection will only take on its final form once suitable premises have been secured. The most optimal option seems to be to locate it in the context of the other collections of the TMS in Bistra near Vrhnika, as the museum is just in the initial phase of reconstruction and content renovation.

Martina Orehovec, M.Sc., Janez Slak, M.Sc.

Slovenska geodetska zbirka na gradu Bogenšperk v letih od 1987 do 2021, galerija.
Slovene Geodetic Collection at Bogenšperk Castle between 1987 and 2021, gallery.

Razstava v Depojih državnih muzejev v Pivki na dan odprtja 18. maja 2022.
The exhibition in the Depots of national museums in Pivka on its opening day 18 May 2022.

2 GEODETSKA STROKA – SPLOŠNO

Ste vedeli, da brez geodezije sodobna država ne more obstajati? Poskušajmo razložiti.

Geodezija je ena najstarejših geoznanosti. Njeni začetki segajo v davno preteklost. Že pred tisočletji so ljudje risali skice, ki jih lahko imenujemo karta ali katastrski načrt. Lokacija, orientacija in oblika objektov, za katere še danes ne vemo natančno, kako so jih sploh lahko zgradili, je zahtevala geodetsko izmero. Kaj pa velikost Zemlje, kako so jo pred več kot 2000 leti sploh lahko določili?

Helmert je zapisal, da je geodezija veda, ki se ukvarja z merjenjem in predstavitvijo Zemlje, vključno z njenim gravitacijskim poljem. Ta definicija drži še danes. Če jo dopolnimo z bolj praktičnim opisom, lahko rečemo, da geodezija nudi zanesljive podatke o dimenzijah in obliki Zemlje, delih zemeljske površine in objektih na Zemlji ter njihovih spremembah v času. Geodezija se ukvarja z izmero zemeljskega površja, z njegovim pravilnim prikazom na načrtih in kartah, z uporabo GIS (GeoInformacijski Sistemi) tehnologije v analizah prostora, evidentiranjem in urejanjem nepremičnin ter nepremičninskih evidenc in upravljanjem s prostorom.

Geodezija je področje, na katerem se srečujejo matematika, fizika, merska tehnologija, računalništvo, informatika, kartografija pa tudi pravo, ekonomija, prostorsko načrtovanje, predvsem pa delo z ljudmi.

Nalogo določitve velikosti in oblike Zemlje rešuje področje geodetske astronomije in satelitske geodezije kot najbolj znanstveni del stroke. Uporaba sodobnih satelitskih tehnologij, merjenje težnostnega polja, nivojev svetovnih morij, uporaba terestričnih geodetskih merskih metod omogoča natančen opis Zemlje.

Z vzpostavitvijo geodetskih mrež v okviru države s postopki temeljne geodetske izmere metrično opisujemo prostor, v katerem živimo. Z uporabo sodobnih tehnologij množičnega zajema prostorskih podatkov (fotografiranja, radarskega snemanja, laserskega skeniranja s satelitov, letal, brezpilotnih letalnikov) geodezija omogoča vzpostavljanje podrobnih grafičnih prikazov prostora in ustvarjanje virtualnih prostorskih modelov, ki postajajo virtualna resničnost.

Geodezija v inženirstvu je mlado in kompleksno področje, povezano z gradnjo objektov, strojegradnjo ter kontrolnimi merjenji. Nepogrešljiva je v vseh fazah gradnje od zasnove do izgradnje in tudi po njej. Za kontrolo objektov vzpostavlja inovativne hibridne merilne sisteme, v katerih poveže različne merilne senzorje, ki zagotavljajo visoko mersko točnost. Podobna točnost je potrebna tudi v strojegradnji, kjer geodezija sodeluje pri zagotavljanju prave geometrije proizvodnih linij, kontrolira delovanje robotov ali pa ugotavlja pravilnost oblik in dimenzij industrijskih proizvodov v npr. avtomobilski in letalski industriji.

V urejeni državi v prostoru ne smemo ničesar spremeniti brez pridobitve ustreznih dovoljenj. Posege v prostor predpisujejo različni državni in občinski prostorski akti. Zemljiško urejanje, ekološko urejanje in oblikovanje prostora ter gradbeno tehnično urejanje zahtevajo ustrezne podatke o prostoru, ki jih lahko ponudi samo geodet.

Urejeni lastniški odnosi na nepremičninah so osnova za zdravo gospodarjenje s prostorom. Zemljiški kataster, najstarejša geodetska evidenca, je bil vzpostavljen za zaščito lastnine in obdavčenje v času Marije Terezije. Geodezija zanj skrbi že več kot 200 let in tudi danes se z njim ukvarja večina geodetov v Sloveniji.

Podatki, ki jih pridobiva, analizira in v svojih evidencah vodi geodezija, so pomembni za državo in občine, za podjetja, ki opravljajo svojo dejavnost v prostoru, in za vsakega državljana, ki poseduje ali uporablja kakršnokoli nepremičnino. Poleg tega so prostorski podatki, ki jih pridobiva, ureja in v svojih evidencah vodi geodezija tudi referenca za prostorske podatke vseh drugih strok.

Slovenija ima kot mlada država vse, kar se za moderno državo spodobi. Tudi zaradi geodezije. Nekatere stvari še niso povsem urejene, nekatere kot povsod ne bodo nikoli popolne. Geodeti za marsikatero od njih skrbimo in poskrbimo. Tudi za državno mejo. Ni težko, potem ko se politiki dogovorijo. Geodezija je tista, ki bo povedala, kje v naravi je konfin, ga postavila in mu dala koordinate. In s tem zarisala državo.

dr. Dušan Kogoj

2 GEODESY – AN OVERVIEW

Did you know that a modern country cannot exist without surveying? We will try to explain.

Geodesy is one of the oldest geosciences. Its origins go back a long way. Thousands of years ago, people already drew sketches that we may consider a map or a cadastral plan. The location, orientation, and shape of buildings – still a mystery exactly how they were constructed – required surveying. What about the size of the Earth? How could people possibly have determined it more than two thousand years ago?

According to the classical definition, attributed to F. R. Helmert, geodesy is the science of the measurement and mapping of the earth's surface, including its gravitational field. This definition still holds today. Complemented by a more practical description, geodesy provides reliable information on the size and shape of Earth, specific parts or regions, objects, and their changes over time. Geodesy and land surveying specializes in measuring the Earth's surface, providing its accurate display on plans and maps, the use of GIS (GeoInformation Systems) technology in spatial analysis, the registration, and management of the real estate and property records, and spatial management. It is a field where mathematics, physics, measurement technology, computer science, information technology, cartography, law, economics, spatial planning, and interacting with people, meet.

The task of determining the size and shape of the Earth is addressed by geodetic astronomy and satellite geodesy as the most scientific part of the discipline. The use of modern satellite technologies, gravity surveys, sea level measurements, and terrestrial surveying methods allows an accurate description of the Earth.

By land surveying and mapping, surveyors establish national and local geodetic networks that provide (geo)metric interpretation of the space we live in. Using modern technologies for massive spatial data acquisition (photogrammetry, radar imaging, laser scanning, satellite imagery, drones), geodesy is engaged in producing detailed graphical representations of space and the creation of virtual spatial models, which are becoming a virtual reality.

Engineering survey is a young and complex field related to building construction, mechanical engineering, and control measurements. It is indispensable in all phases of construction and beyond. It creates innovative hybrid measurement systems in deformation monitoring, combining different measurement sensors to ensure high accuracy. Similar accuracy is required in mechanical engineering, where surveying is involved in setting up and aligning industrial machinery, in-situ calibration of industrial robots, or making geometrical checks on finished components in, for instance, automotive and aeronautical industries.

In a regulated country, nothing can be changed in space without the appropriate permits. Various national and municipal spatial planning acts regulate land use. Land planning, ecological and spatial planning, and construction engineering require relevant spatial data that only a surveyor can provide. As the oldest surveying record, the land cadastre was established to protect property and for taxation purposes during the period of Empress Maria Theresa. The surveying profession has maintained it for more than two hundred years, and even today, most surveyors in Slovenia deal with it.

The data that geodesy acquires, analyses, and keeps in its records is vital for the State and municipalities, companies operating in space-related fields, and every citizen who owns or uses any kind of real estate. In addition, the spatial data that surveying acquires, organises, and keeps in its records is also a reference for spatial data of all other disciplines.

As a young country, Slovenia has everything a modern country should have. Also, thanks to geodesy. Some issues have not been sorted out yet. Some, same as elsewhere, will never be perfect. However, the surveyors work on and work out many of them, including the national border. It is not difficult once the politicians agree. The geodesy will tell where the boundary is on the ground, place it, and give it coordinates. And, consequently, plot the country.

Dušan Kogoj, Ph.D.

3 ZEMLJA – OBLIKA IN VELIKOST

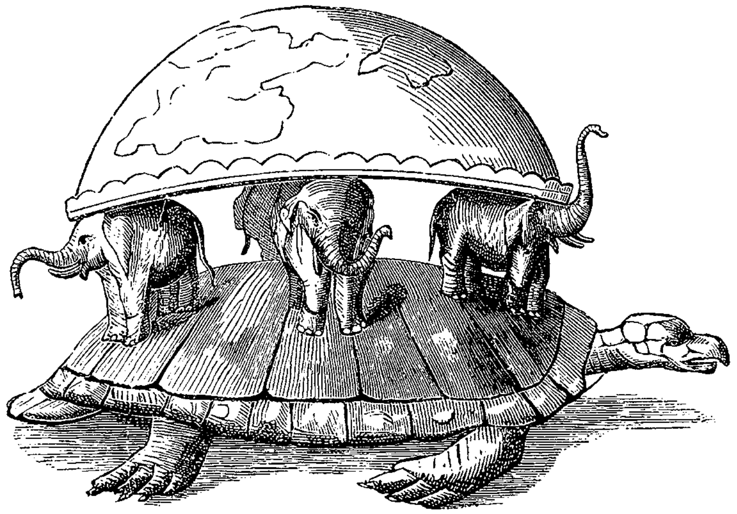
EARTH – SHAPE AND SIZE

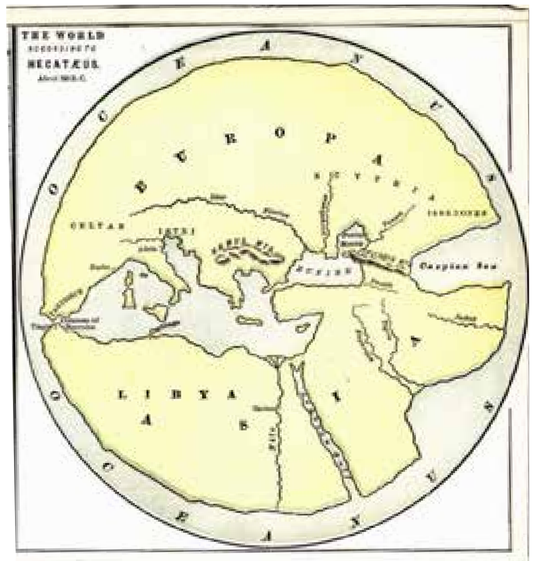
Verjetno si mislimo, da sta oblika in velikost Zemlje znani že stoletja in da je ta zgodba končana. Pa ni čisto tako. Sodobni sistemi satelitske navigacije zahtevajo zelo natančen opis dimenzij Zemlje. Tako natančen, da se vprašamo, ali je to sploh mogoče. Če želimo namreč z uporabo sistema GPS določiti nadmorsko višino z geodetsko točnostjo, to je recimo 1 cm, moramo poznati obliko in velikost Zemlje s točnostjo 1 centimeter.

V daljni preteklosti so bile predstave o obliki in velikosti Zemlje zelo »primitivne«. Bile pa so tako domišljene, da komaj verjamemo, da so ljudi prepričale. Iz hinduizma je znana razlaga, da je Zemlja del krogle, ki jo podpirajo štirje sloni.

We might assume that the shape and size of the Earth have been known for centuries and that we are done with this story. However, that's not quite the case. Modern satellite navigation systems require a highly detailed description of the Earth's dimensions. Indeed, precise to the point that one might wonder whether it is even possible. If we want to use GPS to determine elevation (height above mean sea level) with geodetic accuracy, say 1 cm, we need to know the shape and size of the Earth with 1 cm accuracy.

In the distant past, people imagined the Earth in many different ways. Some ideas were so farfetched that one finds it difficult to believe they convinced people. In Hinduism, the Earth was represented as a curved surface supported by on the backs of four elephants.



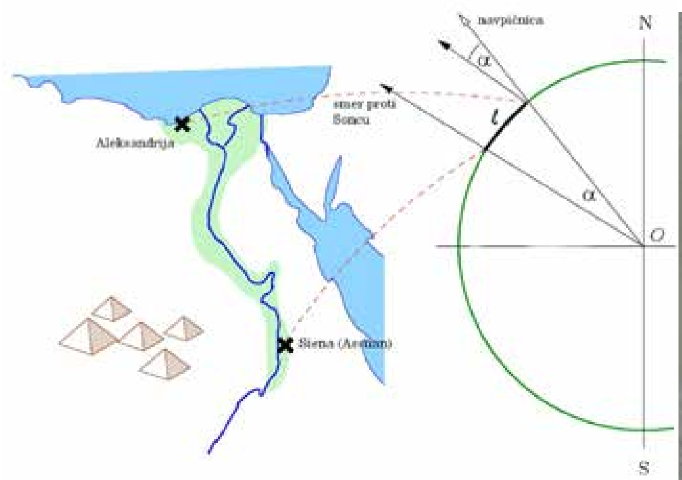


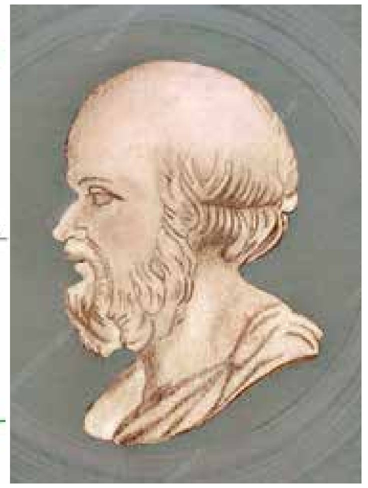
Potovanja in pripovedovanja, predvsem pa opazovanja narave so vse bolj razkrivali resnico o Zemlji. Nekaj stoletij pred našim štetjem so bile predstave o Zemlji še vedno zelo omejene. Tako Anaksimander in Tales (652–547 pr. n. št.) opisujeta Zemljo kot disk, ki plava v neskončnem oceanu.

Discoveries and travellers' accounts, and in particular observations of nature, have increasingly revealed the true nature of the Earth. Several centuries BC, ideas about the Earth were still far from the actual reality. Thales (652-547 BC) and Anaximander describe the Earth as a disc floating on in an infinite ocean.

V večini zapisov zasledimo, da je o okrogli Zemlji prvi govoril Pitagora (569–475 pr. n. št.). Opazoval je Lunin mrk in ukrivljeno senco, ki jo zariše Zemlja na Luni. Na tej osnovi je sklepal, da je Zemlja okrogla, ni pa vedel, kako velika je.

Pythagoras (569-475 BC) was the first to propose a spherical Earth. He observed a lunar eclipse and the curved shadow the Earth casts on the Moon. Thereupon he concluded that the Earth was round, but he didn't know its size.



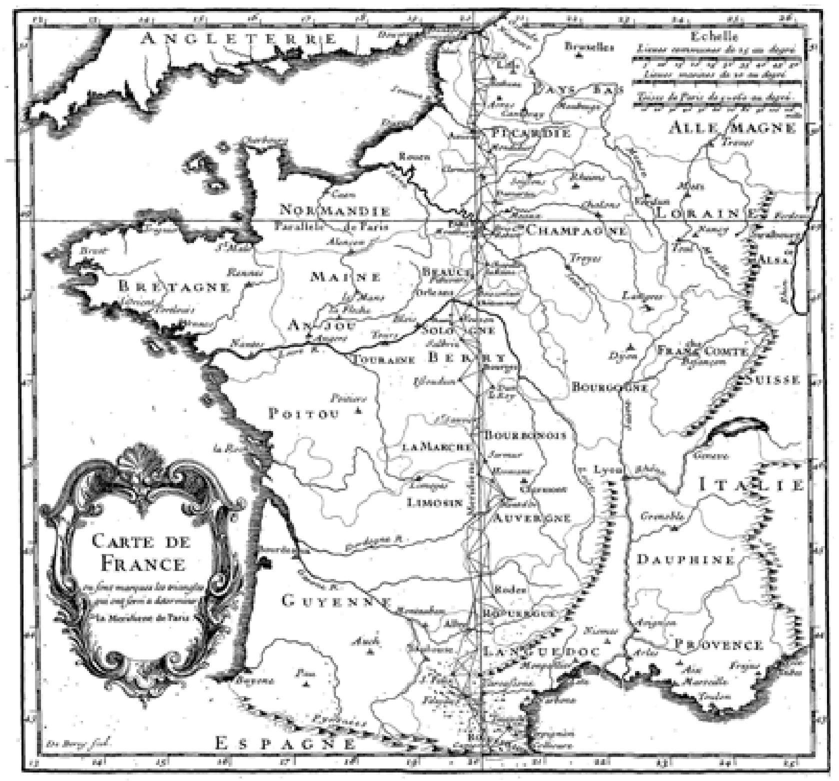


Velikost Zemlje je prvi izmeril Eratosten iz Aleksandrije (276–195 pr. n. št.). Pa ne samo to. Definiral je tudi metodo izmere. V sodobnem strokovnem jeziku bi rekli, da so za to potrebne astronomske geodetske meritve. Metodo, ki jo je utemeljil Eratosten, je geodetska astronomija kot edino uporabljala do sredine prve polovice 20. stoletja.

Eratosten je vedel, da je Zemlja okrogla. Če izmerimo dolžino dela meridianskega loka in njemu pripadajoči središčni kot, lahko določimo obseg. In Eratosten je naredil prav to. S štetjem obratov kolesa je izmeril razdaljo med Aleksandrijo in Sieno (smer sever-jug), pripadajoči središčni kot pa z merjenjem dolžine sence v vodnjaku. Podobno so to počeli Arabci (827, Musa Ibn Shakir), le da so za merjenje središčnega kota uporabljali kvadrante in opazovali zvezde. Fernel, ki je v Franciji s postopki, podobnimi arabskim, organiziral merjenje velikosti Zemlje, je leta 1528 objavil za takrat neverjetno natančno vrednost polmera Zemlje – R = 6373 km.

Eratosthenes of Alexandria (276-195 BC) was not only the first person to measure the size of the Earth, but he also determined the method of measuring. Indeed, his approach was the only one to survive until the emergence of satellite measurement systems in the second half of the 20th century.

He recognised that the Earth was a sphere in space. The circumference can be determined by measuring the central angle and circular arc. That's precisely what Eratosthenes did. He had professional walkers measure the distance between Alexandria and Syene (north-south direction) and measured the difference in shadow angles cast by the sun on a vertical rod. A similar method was used in the Arabic world (827, Mūsā Ibn Šākir) with a difference in using the sine quadrant for measuring celestial angles. Jean Fernel, who organised the measurement of the earth circumference in France with methods similar to the Arabic, calculated it within one percent of the current value, i.e., R = 6373 km.



Sodoben način določitve velikosti Zemlje s postopki geodetske astronomije temelji na merjenju središčnega kota z opazovanjem višinskih kotov do zvezd z geodetskimi instrumenti, ki zagotavljajo podsekundno točnost. Dolžine delov meridianskih lokov se merijo z metodo triangulacije z opazovanjem zvezd, dolžine loka pa z metodo triangulacije (Snellius, 1580–1626). Na tak način so velikost Zemlje od 17. stoletja izmerili velikokrat. Posamezne merske kampanje so trajale več desetletij (Struve, 1816–1855). Ugotovili so, da Zemlja ni krogla, ampak rotacijski elipsoid. Zanimivo je, da so prav na osnovi teh meritev definirali tudi meter kot mednarodno mersko enoto (1 meter je desetmilijonti del kvadranta meridiana, ki poteka prek Francije).

The modern way of determining the size of the Earth using geodetic astronomy is based on measuring the central angle by observing the elevation angles with geodetic instruments that provide sub-second accuracy. The lengths of the meridian arc segments are measured by observing the stars, and the arc lengths are measured by the triangulation method (Snellius, 1580-1626). The size of the Earth has been measured in this way many times since the 17th century. Individual measurement campaigns lasted several decades (Struve, 1816-1855). They concluded that the Earth is not a sphere but a rotational ellipsoid. Interestingly, based on these measurements, the metre was defined as the international unit of measure (1 metre is one ten-millionth of the quadrant of the meridian passing through France).

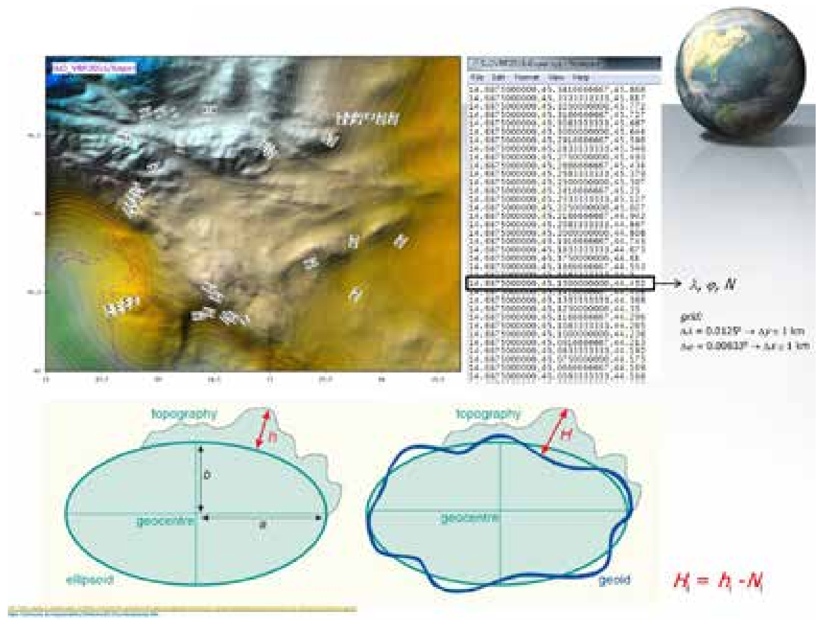
Današnja satelitska merska tehnologija (Global Navigation Satellite System – GNSS) zahteva zelo natančno poznavanje oblike in velikosti Zemlje. Najnatančnejša ploskev, ki opiše Zemljo, je fizikalno definirana na osnovi težnostnega polja. Zemljo opišemo z geoidom, to je s ploskvijo, ki povezuje točke enakega težnostnega potenciala in sovpada z nivojem srednje morske gladine. Ploskev geoida je z geodetskega stališča zelo razgibana. Spominja na ne preveč zdrav krompir.

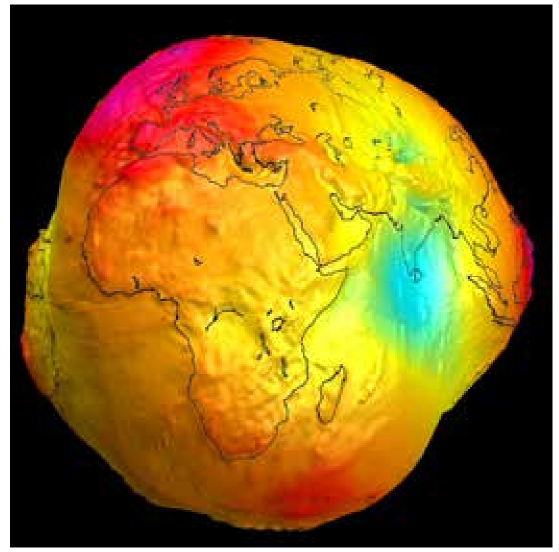
Today's satellite measurement technology (Global Navigation Satellite System – GNSS) requires knowledge of the exact shape and size of the Earth. The most precise surface that describes the Earth is physically defined based on the gravitational field. The mathematical figure of the Earth is called a geoid, i.e., the equipotential surface of the Earth's gravity field coinciding with the mean sea level. The surface of the geoid is very irregular, looking somewhat like a not-too-good potato.

Prav ta razgibanost pa zahteva zelo zapletene in natančne geofizikalne in geodetske meritve klasične in satelitske geodezije. Kompleksni izračuni omogočajo opis ploskve geoida na način, s katerim velikost merjenega prostora lahko določimo z geodetsko točnostjo. Če želimo s tehnologijo GNSS izmeriti nadmorsko višino, dodamo višini, ki jo izračuna sistem GNSS, geoidno ondulacijo (podatek o geoidu).

Natančnost določitve geoidne ondulacije direktno vpliva na natančnost nadmorske višine. Če želimo natančnost na centimeter, je treba obliko in velikost Zemlje izmeriti z natančnostjo boljšo kot en centimeter.

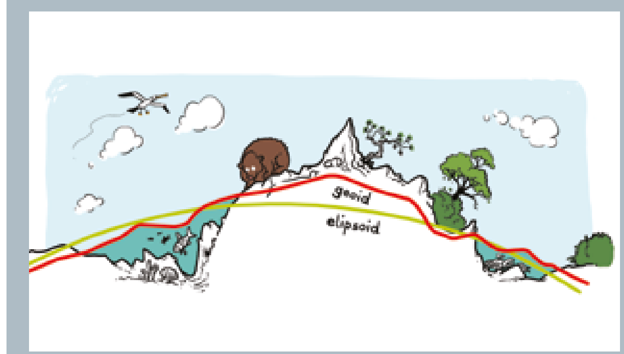
These irregularities require very complex and precise geophysical and geodetic measurements in terms of classical surveying and satellite geodesy. Complex calculations allow the geoid surface to be described in a way that enables measuring the size of the measured area with geodetic accuracy. To determine the orthometric height (height above sea level) using GNSS technology, a geoid undulation (geoid height) is added to the height computed by the GNSS system. The geoid undulation's accuracy directly affects the orthometric height's accuracy. If we want 1 cm accuracy, the shape and size of the Earth must be measured to an accuracy better than one centimetre.





Geoid Slovenije z vrednostmi geoidnih višin na grafičnem prikazu z izolinijami ter v preglednici z numeričnimi vrednostmi. Namen preračuna je prikazan v skicah.

Geoid of Slovenia with geoid heights in a graphical representation with isolines and in a table with numerical values. Pictures above show height h above the geocentric ellipsoid (left), and height H above the Geoid (right).



Geoid

'Najboljši' približek oblike in velikosti Zemlje. Geoid je izhodiščna ekvipotencialna ploskev zemeljskega telesa, to je tista, ki sovpada s srednjo gladino svetovnih morij in je namišljeno podaljšana pod celine.

Geoid

As close to the Earth's shape and size as it gets. The geoid is the planet's gravity field's equipotential surface that coincides with mean sea level and extends through the continents.

4 KAKO IZMERIMO PROSTOR – TEMELJNA GEODETSKA IZMERA

LAND SURVEYING AND MAPPING

[26]

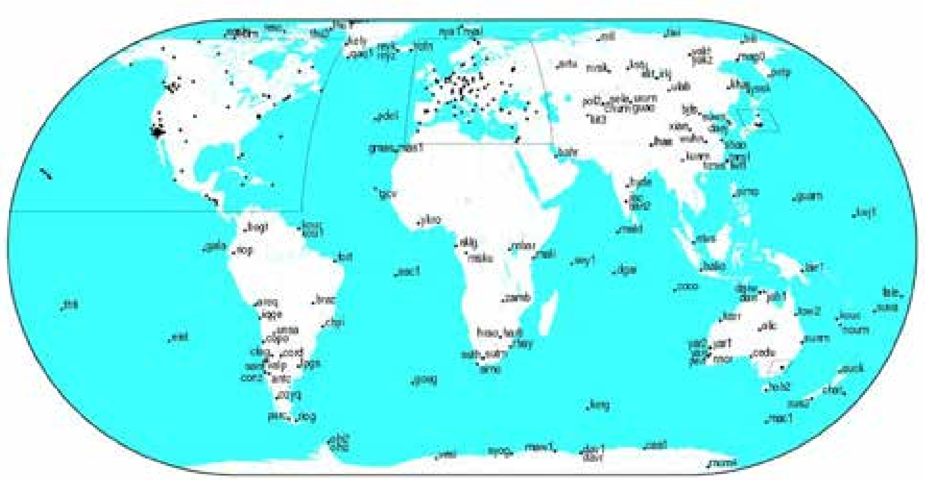
Geodetska točka.
A geodetic point.

Si predstavljate, kako lahko zelo hitro izmerimo npr. oddaljenost mejnega kamna na tromeji Avstrije, Madžarske in Slovenije od piranskega svetilnika na najbolj izpostavljenem delu piranske Punte, na Rtu Madona? Za geodeta nič lažjega, če … ker …

… geodeti za izmero prostora vzpostavimo bazo izmere, ki nam omogoča merjenje vsakega delčka naše Slovenije. Bazo izmere predstavlja niz geodetskih točk, ki jih povežemo v geodetsko mrežo in jim določimo koordinate – s številkami opišemo njihov položaj v prostoru. V okviru države vzpostavimo državni koordinatni sistem, ki ga povežemo v svetovni sistem. Koordinatni sistem materializiramo z geodetskimi točkami, ki jih označimo (stabiliziramo) z izbranimi načini. Klasična terestrična tahimetrična izmera zahteva na desettisoče teh točk.

Have you ever asked yourself how quickly we can measure, for example, the distance between the border stone on the tripoint of Austria-Hungary-Slovenia and the Piran lighthouse at the most exposed part of the Piran Punta, the Madona Cape? Nothing is more straightforward for a surveyor if … because …

… surveyors set up a database allowing us to measure every part of our country. The surveying database consists of geodetic points stabilised in a network and assigned coordinates – numbers that precisely describe their location in space. A national reference coordinate system established within a country is linked to the global system. This coordinate system, in nature, consists of positional networks in a field of stabilized and marked geodetic points of different types. The classical tachymetric terrestrial surveying requires tens of thousands of points.

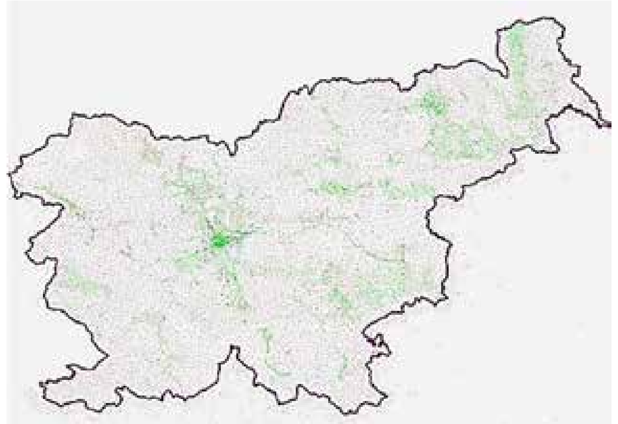


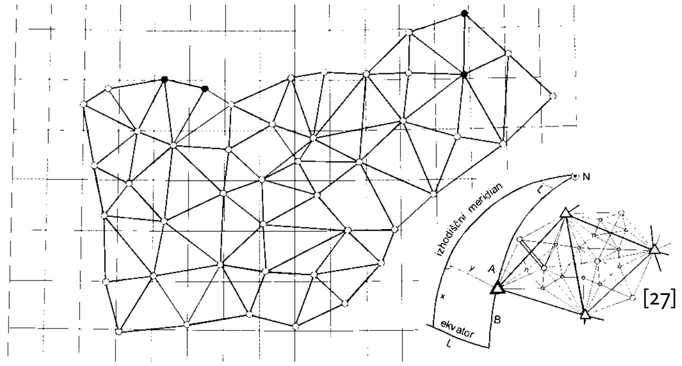
Geodetske točke povežemo v svetovni sistem in tvorimo globalne geodetske mreže, ki predstavljajo okvir geodetske izmere za celo Zemljo.

Global geodetic network – a network of permanent GNSS (Global Navigation Satelite System) points.

V okviru države so te točke na občutno manjših oddaljenostih. Pri klasični terestrični izmeri si želimo, da bi bila 1 točka na 4 ha površine države. V tem primeru bi poljubno točko Slovenije s postavitvijo geodetskega instrumenta na točko mreže in enostavnimi meritvami lahko izmerili v par minutah. Deset minut za svetilnik in deset za mejni kamen in razdalja med njima bi bila izračunana.

Within the country, these points are located at considerably smaller distances. In classical terrestrial surveying, we would like 1 point per 4 ha of the territory. In this case, we could measure any point in the country in a few minutes with a geodetic instrument on a network point and some simple measurements. Ten minutes for a lighthouse and ten minutes for a border stone and the distance between them would be calculated.





[27]

Državna geodetska mreža – astrogeodetska mreža Slovenije in geodetske točke horizontalnih državnih mrež.

National geodetic network – astro-geodetic network of Slovenia and geodetic points of horizontal national networks.

1 točka na 4 ha površine pomeni, da bi Slovenija teoretično potrebovala 506.775 takih točk. To je nepredstavljivo in tega nikoli ni bilo. In tega tudi ne potrebujemo več. Sodobna tehnologija satelitske geodezije, uporaba sistemov GNSS za geodetsko izmero ponuja drugo rešitev. Civilni kontrolni segment (mreža permanentnih GNSS točk – omrežje SIGNAL) zagotavlja infrastrukturo, ki teoretično omogoča izmero države z geodetsko natančnostjo. Omrežje tvori le 30 GNSS postaj. Tehnologija satelitskega merjenja GNSS torej, vsaj na prvi pogled, ne potrebuje veliko geodetskih točk.

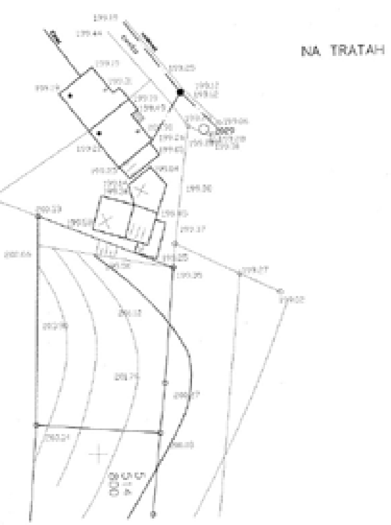
1 point per 4 ha of land means Slovenia would need 506,775 such points, which is inconceivable and has never been the case. Besides, we don't need it anymore. Modern satellite geodesy technology, using GNSS systems for surveying, gives an alternative. The network of permanent GNSS points – the SIGNAL network provides the infrastructure that theoretically allows the country to be surveyed with geodetic accuracy. It consists of only 30 GNSS stations. Therefore, GNSS satellite measurement technology does not, at first sight, need many geodetic points.

Geodetska mreža (mreža geodetskih točk) predstavlja geometrično osnovo detajlne izmere, ki jo lahko izvedemo na različne načine. Najbolj klasična je točkovna izmera, pri kateri »obiščemo« vsako točko, ki jo merimo.

A geodetic network (a network of geodetic points) is the geometric basis of a detailed survey, which can be accomplished in various ways. The most traditional is point measurement, where you „visit“ each point you measure.

Geodetski načrt je osnova za najrazličnejše dejavnosti v prostoru, npr. pri prostorskem planiranju, gradnji objektov, opazovanju, vzdrževanju objektov, varovanju lastnine – urejanju parcelnih mej, dedovanju …

Geodetic plans are the basis for various activities in space, for instance, in spatial planning, construction, observation, maintenance of structures, property protection – regulation of parcel borders, inheritance, etc.

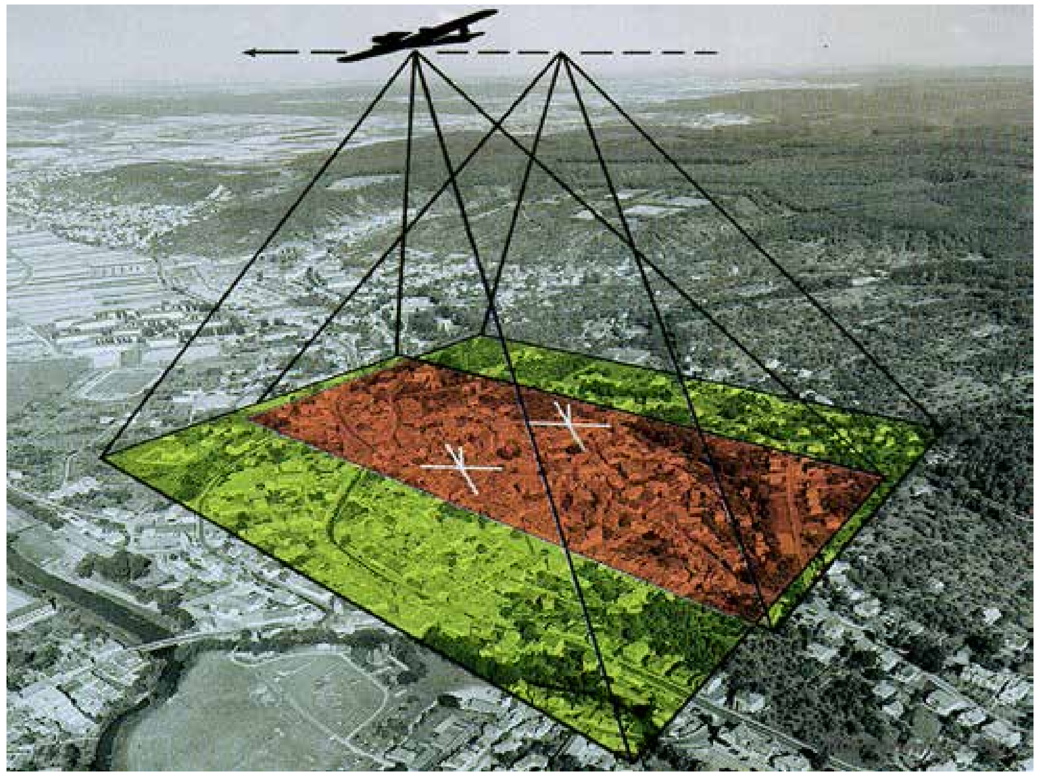


Poleg točkovnega merjenja prostora se vse bolj razvija tudi množični zajem. Prostor, zemeljsko površino in objekte na njej fotografiramo s satelitov, letal, brezpilotnih letalnikov, snemamo ga z radijskimi valovi, ga lasersko skeniramo iz zraka ali s tal ...

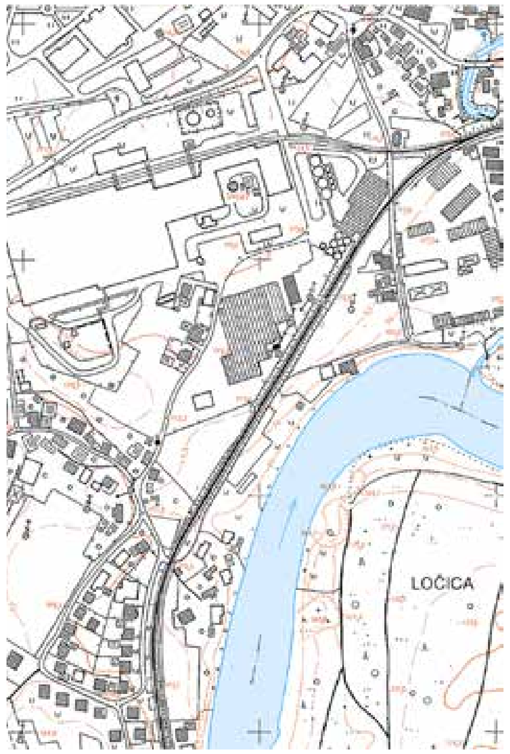
Rezultati izmer z različnimi tehnologijami in metodami so najrazličnejši prikazi na načrtih, kartah, v prostorskih modelih, omogočajo pa tudi ustvarjanje virtualne resničnosti.

In addition to point measurements, land surveying evermore employs modern technologies for massive spatial data acquisition. Technologies that produce images of space, the Earth's surface and inhabited land include satellite imagery, airplanes, drones, radar imaging, airborne or ground laser scanning, etc.

The outcomes of surveys using different technologies and methods are various graphical representations of space on plans, maps, in spatial models and can also be used to create virtual reality.

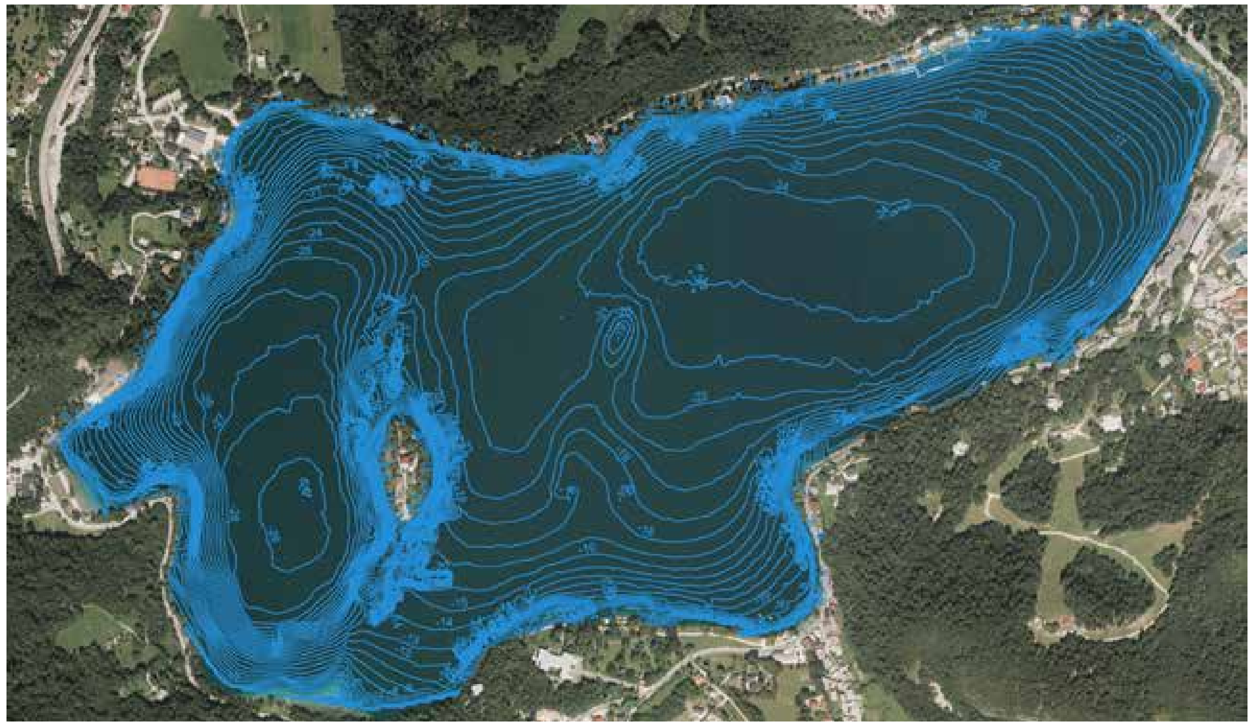


Fotogrametrična izmera, ortofoto, izsek iz državne topografske karte.
Photogrammetric survey, ortophoto, excerpt from the national topographic map..



Poleg klasičnih prikazov prostora izdelujemo geodeti tudi različne posebne prikaze. Z dodatnimi hidrografskimi meritvami npr. ugotavljamo podvodni relief jezer, rek in morja.

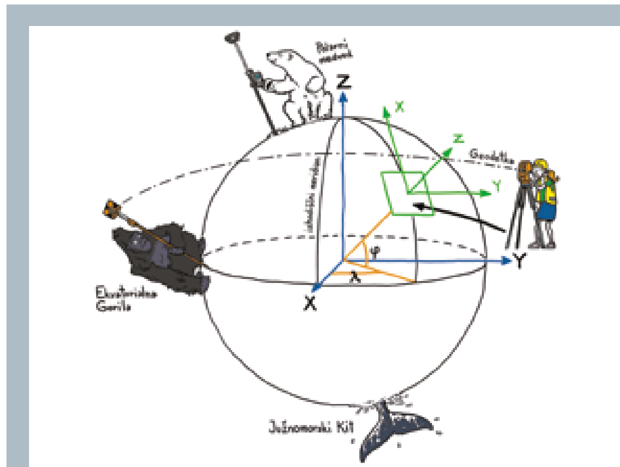
In addition to geodetic plans, surveyors produce a variety of other spatial representations. Additional hydrographic measurements determine the underwater relief of lakes, rivers, and the sea.



Prikaz globin Blejskega jezera z izobatami na podlagi DOF – ekvidistanca izobat je 1 m.
Bled Lake's relief represented as depth contours or iso-baths (digital orthophoto) – isobaths' equidistance: 1 m.

Koordinate točke na sredini stopnišča v Depojih državnih muzejev v Pivki.
Coordinates of a point in the middle of the staircase in the Depots of national museums in Pivka.

D48/GK SVS2000 (datum Trst)	D96/TM(ESRS) SVS2010 (datum Koper)	Geografski elipsoid GRS80 Geographical Ellipsoid GRS80
y = 437.155,521 m	e = 436.783,499 m	λ = 14° 11' 19,2397"
x = 58.478,859 m	n = 58.965,116 m	φ = 45° 40' 03,7020"
H = 572,162 m	H = 572,138 m	h = 618,220 m



Koordinate
Če niste vedeli, kaj zgornje dolge številke pomenijo: Koordinate točke določajo njeno oddaljenost od ekvatorja (zemljepisna širina oz. X koordinata) in oddaljenost od poldnevnika Britanskega kraljevega observatorija v Greenwichu (zemljepisna dolžina oz. Y koordinata).

Coordinates
In case you didn't know what upper long numbers meant: The coordinates of a point define its distance from the equator (latitude or X coordinate) and its distance from the meridian of the British Royal Observatory at Greenwich (longitude or Y coordinate).

5 GLOBALNE METODE – GNSS

GLOBAL NAVIGATION SATELLITE SYSTEMS – GNSS

Metode določitve položaja na Zemlji so se z razvojem tehnologije spreminjale. Ena novejših je določitev položaja na podlagi opazovanih razdalj do satelitov – GNSS ali globalni navigacijski satelitski sistemi (Global Navigation Satellite Systems). Sestavljeni so iz treh segmentov:

- vesoljski segment je konstelacija satelitov, ki oddajajo signal uporabnikom,
- kontrolni segment sestavljajo kontrolne postaje na Zemlji, ki spremljajo delovanje satelitov, izračunavajo parametre tirnic satelitov za izračun položajev satelitov v poljubnem trenutku idr.,
- uporabniški segment smo uporabniki, ki na podlagi opazovanj signalov določamo položaj.

Poznamo več globalnih satelitskih sistemov, in sicer:

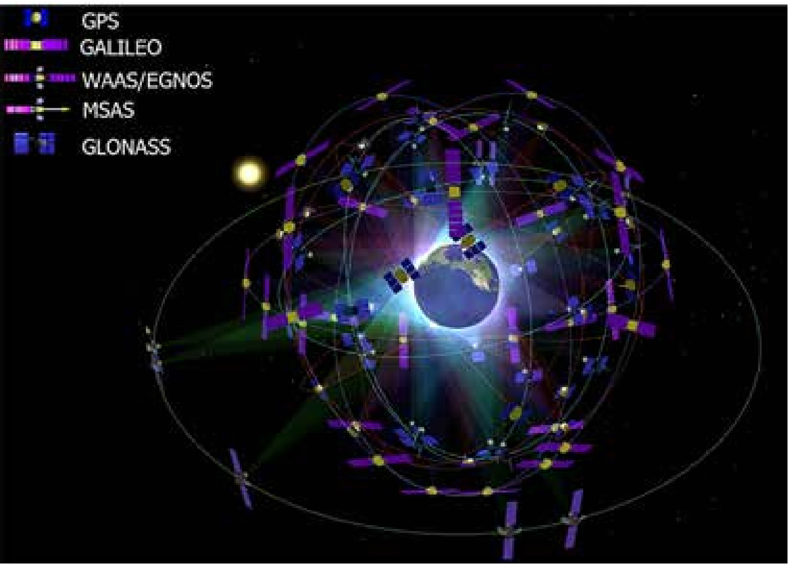
- ameriški GPS (angl. Global Positioning System),
- ruski GLONASS (rus. GLObal'naya NAvigatsionnaya Sputnikovaya Sistema),
- evropski Galileo,
- kitajski Compass/BeiDou,
- japonski QZSS.

Methods of determining the position on Earth have changed as technology has evolved. One of the most recent is positioning based on observed distances to satellites – GNSS, or Global Navigation Satellite Systems. They comprise three segments:

- the space segment describes the constellation of satellites that broadcast signals to the users,
- the control segment is a network of control stations worldwide that monitor the operation of satellites, compare where the satellite says it is with orbit models showing where it should be, etc.
- the user segment includes the equipment that receives satellite signals and outputs a position.

There are several such systems, namely:

- the American GPS (Global Positioning System),
- the Russian GLONASS (GLObal'naya NAvigatsionnaya Sputnikovaya Sistema),
- the European Galileo,
- the Chinese Compass/BeiDou,
- the Japanese QZSS.



Sateliti obkrožajo Zemljo približno 20.000 km visoko. V vsaki točki na Zemlji so teoretično vedno vidni vsaj štirje sateliti. Ti nepretano oddajajo kodirani signal, ki vsebuje vse podatke, potrebne za določitev položaja na Zemlji. S to metodo lahko v vsakem trenutku na kateremkoli koncu Zemlje in v vsakem vremenu določite svoj položaj.

Prvi satelitski navigacijski sistem je bil Transit. Sistem, v osnovi zasnovan za potrebe ameriške vojne mornarice v šestdesetih letih prejšnjega stoletja, je deloval po načelu Dopplerjevega pojava.

Satellites orbit the Earth at the height of about 20,000 km. In theory, at least four satellites are always visible at any point on Earth. They continuously provide coded signals that transmit positioning and timing data that GNSS receivers use to determine their location on Earth. Using this method, we can determine our location at any time, any place, and in any weather.

The first satellite navigation system was Transit. Used originally as the US Navy navigation system in the 1960s, it worked on the principle of the Doppler effect.

Antena za izvajanje izmere GNSS.
Antenna for GNSS surveying.

Državno omrežje za globalno določanje položaja SIGNAL (**Sl**ovenlja-**G**eodezija-**NA**vigacija-**L**okacija) se uporablja za določanje koordinat vseh prostorskih podatkov v evropskem koordinatnem sistemu z instrumenti GNSS.

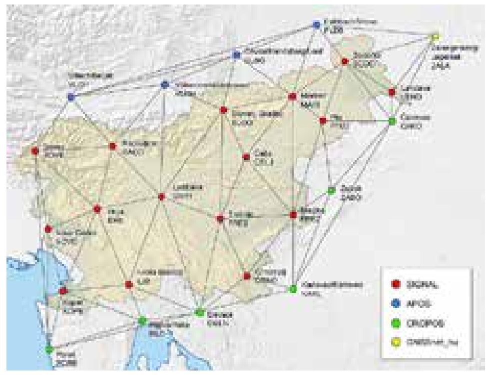
Slovenia's national global positioning network, abbreviated SIGNAL, is used to determine the coordinates of all spatial data in the European coordinate system with GNSS instruments.

Na vseh postajah omrežja SIGNAL in točkah kombinirane geodetske mreže 0. reda so postavljeni sprejemniki GNSS z antenami, ki neprekinjeno sprejemajo signale satelitskih sistemov za določanje položaja. Rezultate opazovanj stalno sprejema nadzorni center v Ljubljani. Tam se podatki uporabijo za natančno izračunavanje položaja teh točk v skupnem Evropskem koordinatnem sistemu (ETRS89), z natančnostjo nekaj mm.

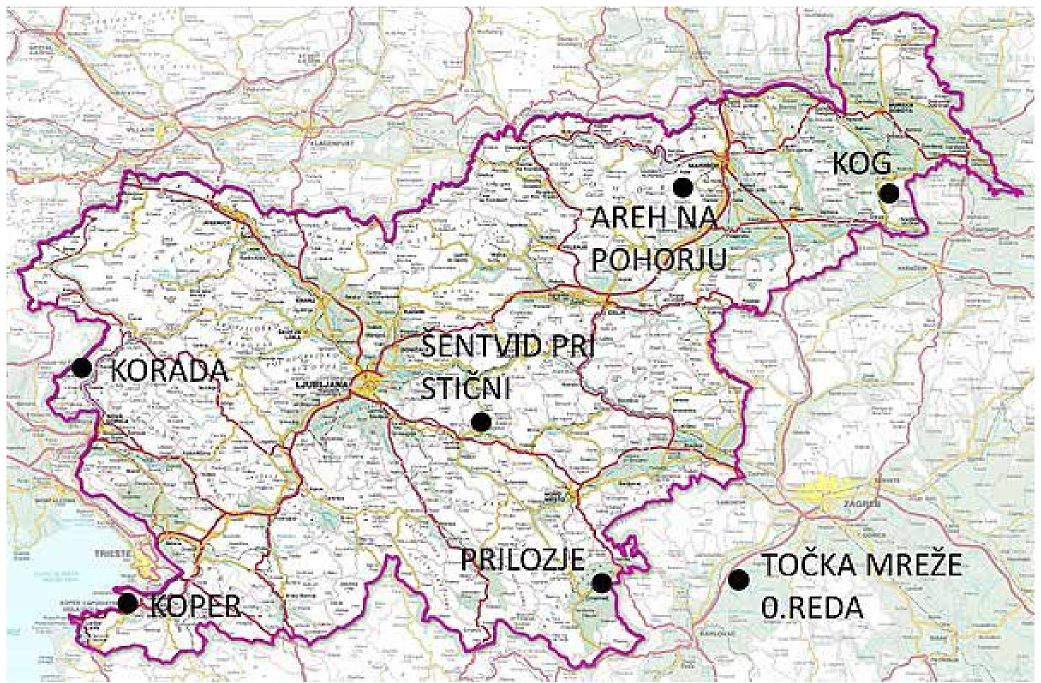
Točke državne geodetske mreže 0. reda predstavljajo najbolj kakovostne državne geodetske točke. Visoka natančnost meritev na točkah te mreže omogoča spremljanje geodinamike (tektonski premiki) in sprememb v razporeditvi zemeljskih mas. S pomočjo točk 0. reda se nadzira tudi uporabniško omrežje SIGNAL.

GNSS receivers with antennas are installed at all SIGNAL network stations and points of the combined zero-order geodetic network to receive signals from satellite positioning systems constantly. The results of the observations are received by the control centre in Ljubljana and used to calculate the exact position of these points in the common European coordinate system (ETRS89) with an accuracy of a few mm.

Points of the zero-order national geodetic network are of the highest quality. Highly accurate measurements at the points of this network allow monitoring of geodynamics (tectonic activity) and the changes in the distribution of landmasses. The zero-order geodetic network is also part of SIGNAL's quality control.



16 stalnih postaj GNSS omrežja SIGNAL.
16 permanent GNSS stations in the SIGNAL network.



Točke kombinirane geodetske mreže 0. reda.
Points of the combined zero-order geodetic network.

6 KARTOGRAFIJA / CARTOGRAPHY

6.1 KARTOGRAFIJA – ZGODOVINA IN KAKO NASTANE KARTA – ZEMLJEVID

CARTOGRAPHY: THE HISTORY AND HOW A MAP IS MADE

Karte oz. zemljevidi že od začetkov človeškega sporazumevanja predstavljajo najbolj učinkovit način izmenjave oz. posredovanja podatkov o prostoru in njegovem stanju. Skozi tisočletja so se spreminjali nosilci podatkov ter oblikovanje in način njihove obdelave. Če so najprej najverjetneje v tla zarisovali preproste risbe, ki so bile ključne za preživetje skupine, so kasneje, na osnovi vse boljšega poznavanja oblike in velikosti planeta Zemlje ter njenih posameznih območij, karte za potrebe evidentiranja in upravljanja prostora izdelovali na glino, kosti, kože in kasneje tudi papir.

Since the beginning of human interactions, maps have been the most efficient way of exchanging and communicating spatial information. Over the millennia, the data media, design and processing have changed. At first, people most likely carve simple drawings into the ground, essential for the group's survival. Later, due to the increasing knowledge of the shape and size of the planet Earth and its respective areas, maps to record and manage space were produced on clay, bone, skin and later also on paper.

Najstarejša najdena karta na oklu mamuta, 22.000 let pr. n. št., odkrita leta 1962 pri kraju Pavlov na Moravskem (Češka).

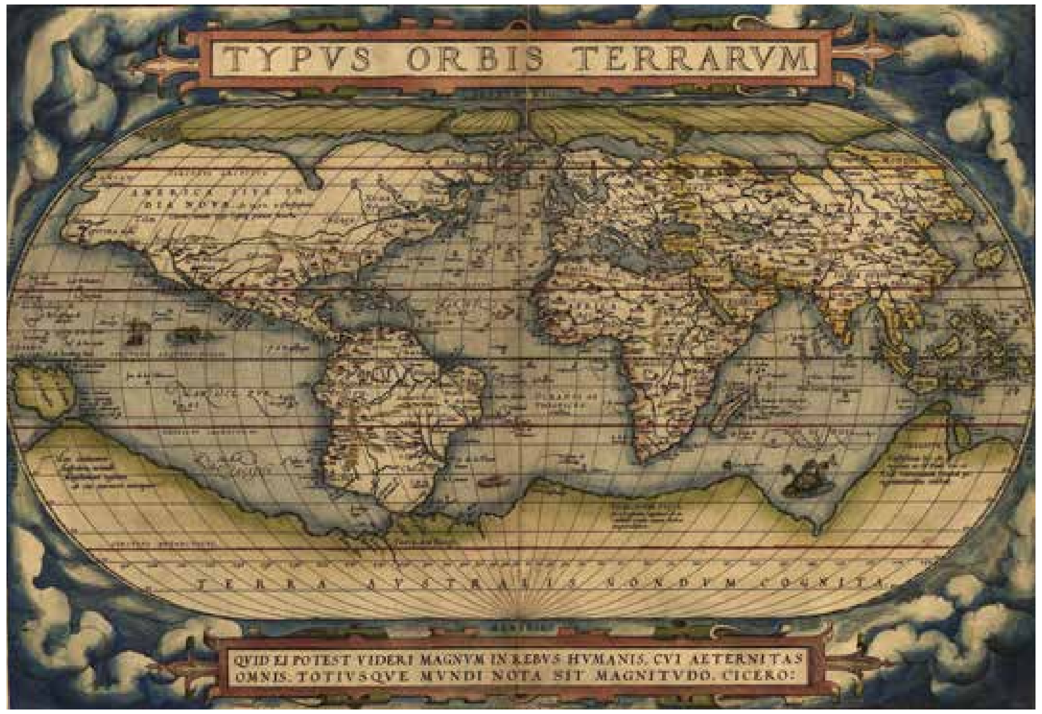
The oldest mammoth tusk map found to this day, 22,000 BC, was discovered in 1962 near Pavlov in Moravia (Czech Republic).

Najstarejše najdbe zarisa na glineni plošči.

The oldest finds of land surveying on clay tablets.

Karte so postale način predstavljanja naprednega znanja, pa tudi sredstvo propagande, kot recimo srednjeveške TO-karte. Z geografskimi odkritji in tiskom se uporaba kart razširi, a le par stoletij kasneje z izboljšanjem točnosti zaradi vojaških strateških razlogov zelo omeji.

Maps have become a way of presenting advanced knowledge, but also a means of propaganda, like the medieval TO-maps. The use of maps expanded with geographical discoveries and printing, but only a few centuries later, as accuracy improved, it became constrained for strategic military purposes.



Na osnovi zapisov izdelana rekonstrukcija antične karte Klavdija Ptolemeja iz 2. stoletja, uporaba kartografske mreže in stožčne projekcije, izkaz visokega znanja in razumevanja.

A reconstruction of an ancient map by Claudius Ptolemy from the 2nd century, based on records. Using a cartographic grid and cone projection is evidence of in-depth knowledge and understanding.

Geografska odkritja in razvoj tiska – razcvet kartografije, globusi, atlasi.

Geographical discoveries and the development of print – the heyday of cartography, globes, atlases.

Srednjeveška propagandna *Mappa Mundi* v *La Fleur des Histoires*, 1459–1463, je poenostavljen prikaz sveta v obliki črk T in O, ki predstavljajo tri kontinente: Azijo (zgoraj), Evropo (spodaj levo) in Afriko (spodaj desno).

The medieval propaganda *Mappa Mundi* in *La Fleur des Histoires* (1459-1463), a simplified representation of the world in the form of the letters T and O, representing the three continents: Asia (top), Europe (bottom left), and Africa (bottom right).

Računalniška izdelava, uporaba kart na e-medijih in vsesplošna dostopnost do podatkov in kart omogoči široko in preprosto uporabo kart z naprednimi predstavitvami 3D, VR in AR in s tem tudi možnost sodelovanja uporabnikov pri oblikovanju.

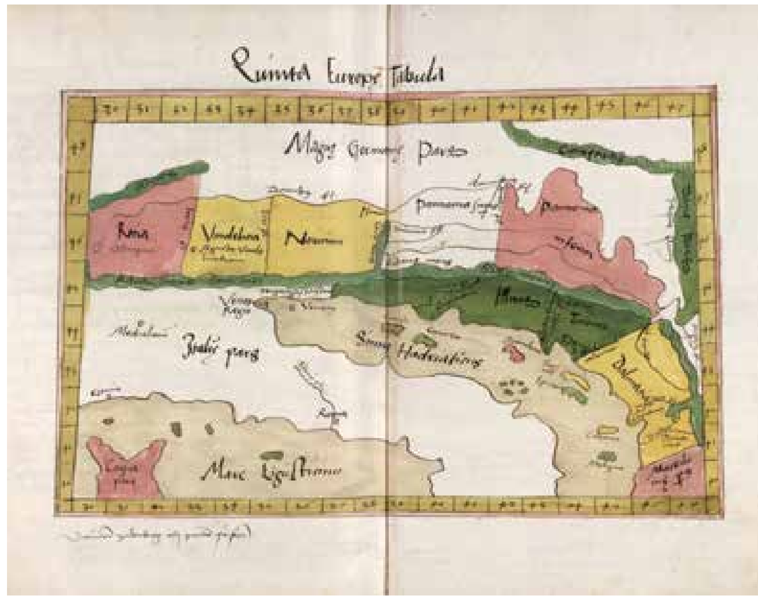
Computer generation, maps on e-media, and the ubiquitous availability of data and maps facilitate extensive and easy use of maps with advanced 3D, VR, and AR representations and thus involve users in their design.

6.2 PRVE UPODOBITVE SLOVENSKEGA OZEMLJA

FIRST DEPICTIONS OF SLOVENE TERRITORY

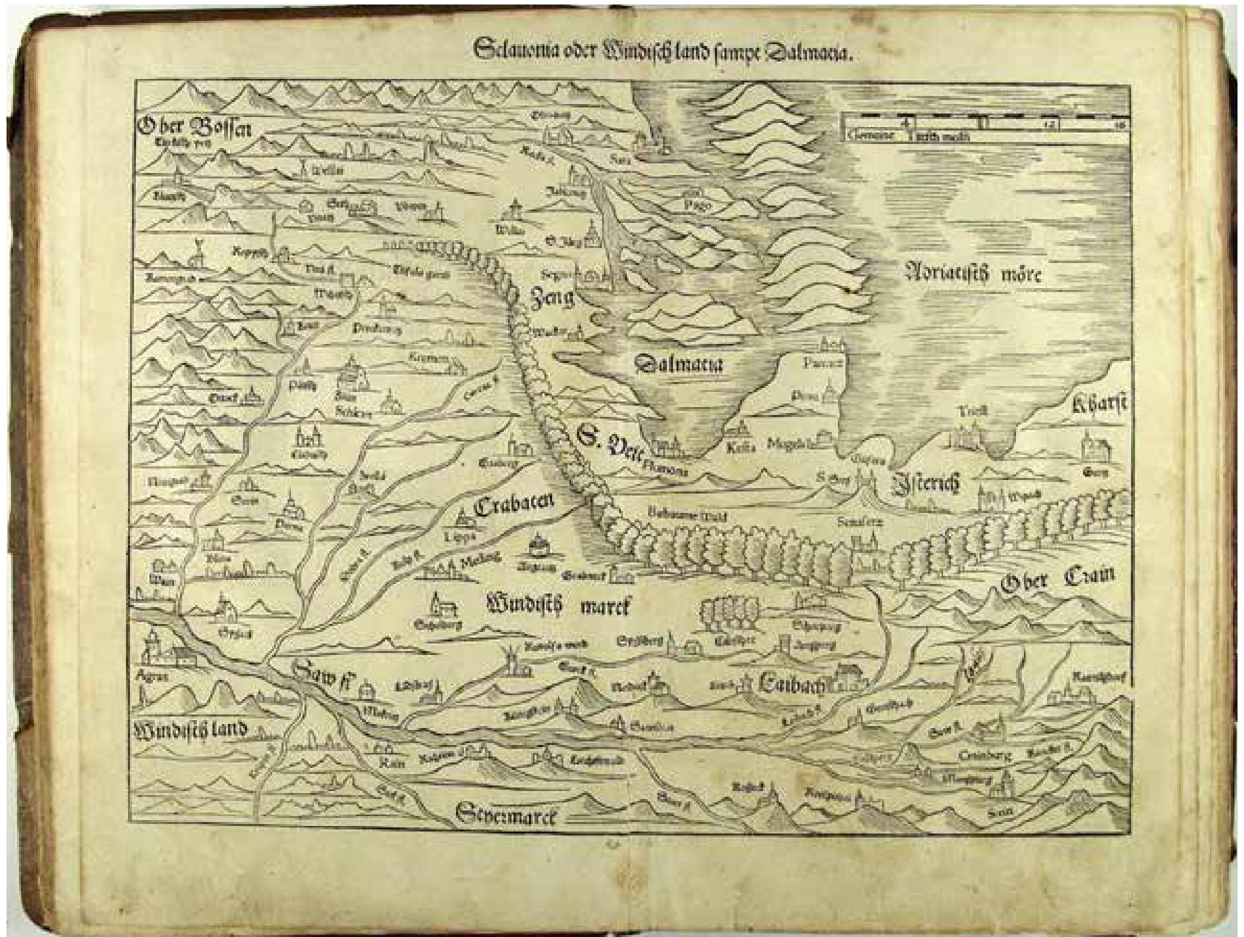
Najstarejši kartografski dokument, na katerem je upodobljeno slovensko ozemlje, je *Peta karta Evrope (Quinta Europe Tabula)* aleksandrijskega učenjaka Klavdija Ptolemeja, upodobljena v prepisu Ptolemejevih kart z začetka 16. stoletja (okoli 1520). 26 latinskim rokopisnim kartam je dodan komentar švicarskega humanista Joachima Vadiana, ki opisuje delo rimskega geografa Pomponija Mele. Format karte 28 x 17 cm, merilo ni določljivo.

The oldest cartographic document depicting ethnic Slovene territory is the *Fifth Map of Europe (Quinta Europe Tabula)* by the Alexandrian scholar Claudius Ptolemy, found in a rare transcription of his maps from the early 16th century (around 1520). Twenty-six Latin manuscript maps are added to a commentary by the Swiss humanist Joachim Vadian on the work of the Roman geographer Pomponius Mela. Map size 28 x 17 cm; the scale is not identifiable.



Naslednja upodobitev slovenskega ozemlja na kartah je *Sclauonia oder Windisch Land sampt Dalmatia iz* leta 1548, njen avtor je Münster Sebastian. Gre za tretjo izdajo lesoreznih zemljevidov Ptolemejeve *Geografije.* Format karte je 34 x 25 cm.

The following depiction is found on the woodcut map *Sclauonia oder Windisch Land sampt Dalmatia* from 1548, by Münster Sebastian. It is the third edition of woodcut maps in the *Geographia* by Ptolemy. Map size is 34 x 25 cm.



V atlasu splošno znanstvenega pomena besede so podatke za slovensko ozemlje prispevali Lazius Wolfgang, Augustin Hirschvogel, Joannes Sambucus in Pietro Coppo. Nizozemski slikar Abraham Ortelius je v atlasu *Theatrum orbis terrarum*, ki je izšel leta 1570, upodobil ozemlje *Goritiae, Karstii, Chaczeolae, Carniolae, Histriae et Windorum Marchae descrip.* Karta velikosti 23 x 34 cm je narisana v približnem merilu 1 : 1.000.000.

The Dutch cartographer Abraham Ortelius is the author/editor of the first atlas in the scientific sense of the word the *Theatrum orbis terrarium*, published in 1570. Maps of Slovene territory were contributed by Augustin Hirschvogel, Joannes Sambucus, Pietro Coppo, and Wolfang Lazius who depicted the territory of *Goritiae, Karstii, Chaczeolae, Carniolae, Histoire et Windorum Marchae describe.* The 23 x 34 cm map is made at an approximate scale of 1:1,000,000.

Pomembno prelomnico v razvoju kartografije predstavlja delo matematika, astronoma in kartografa Gerharda Mercatorja, ki je posebno pozornost posvečal matematičnim elementom zemljevidov. Naši kraji so prikazani na zemljevidu *Karstia, Carniola, Histria et Windorum Marchia*.

Z zemljevida je razvidna matematično pravilna prostorska predstavitev, saj se obris Istre in Kvarnerskih otokov prvič približa današnjim predstavam. Gerharda Mercatorja upravičeno štejemo za pionirja sodobne kartografije. Karte so nastale v obdobju od 1635 do 1670. Format karte je 49 x 38 cm.

An important turning point in the development of the cartography is the work of the mathematician, astronomer, and cartographer Gerhard Mercator, who paid particular attention to the mathematical elements of the maps. Our land is represented on the *Karstia, Carniola, Histria et Windorum Marchia* map.

The map shows a mathematically correct spatial representation as the outline of Istria and the Kvarner islands approximates contemporary presentations for the first time. Gerhard Mercator is rightly considered a pioneer of modern cartography. The 49 x 38 cm maps were made between 1635 and 1670.

Mercatorjeva projekcija, tj. cilindrična projekcija zemljevida, je postala standardna zemljevidna projekcija za navigacijo. Je edinstvena, ker povsod predstavlja sever navzgor in jug navzdol, hkrati pa ohranja lokalne smeri in oblike.

The Mercator projection, i.e., cylindrical map projection, became the standard map projection for navigation. It is unique in representing north as up and south as down everywhere while preserving local directions and shapes.

6.3 VALVASOR – TOPOGRAF

VALVASOR – TOPOGRAPHER

JANEZ VAJKARD VALVASOR (1641–1693) – KRANJSKI PLEMIČ, POLIHISTOR, ČLAN ANGLEŠKE KRALJEVE DRUŽBE

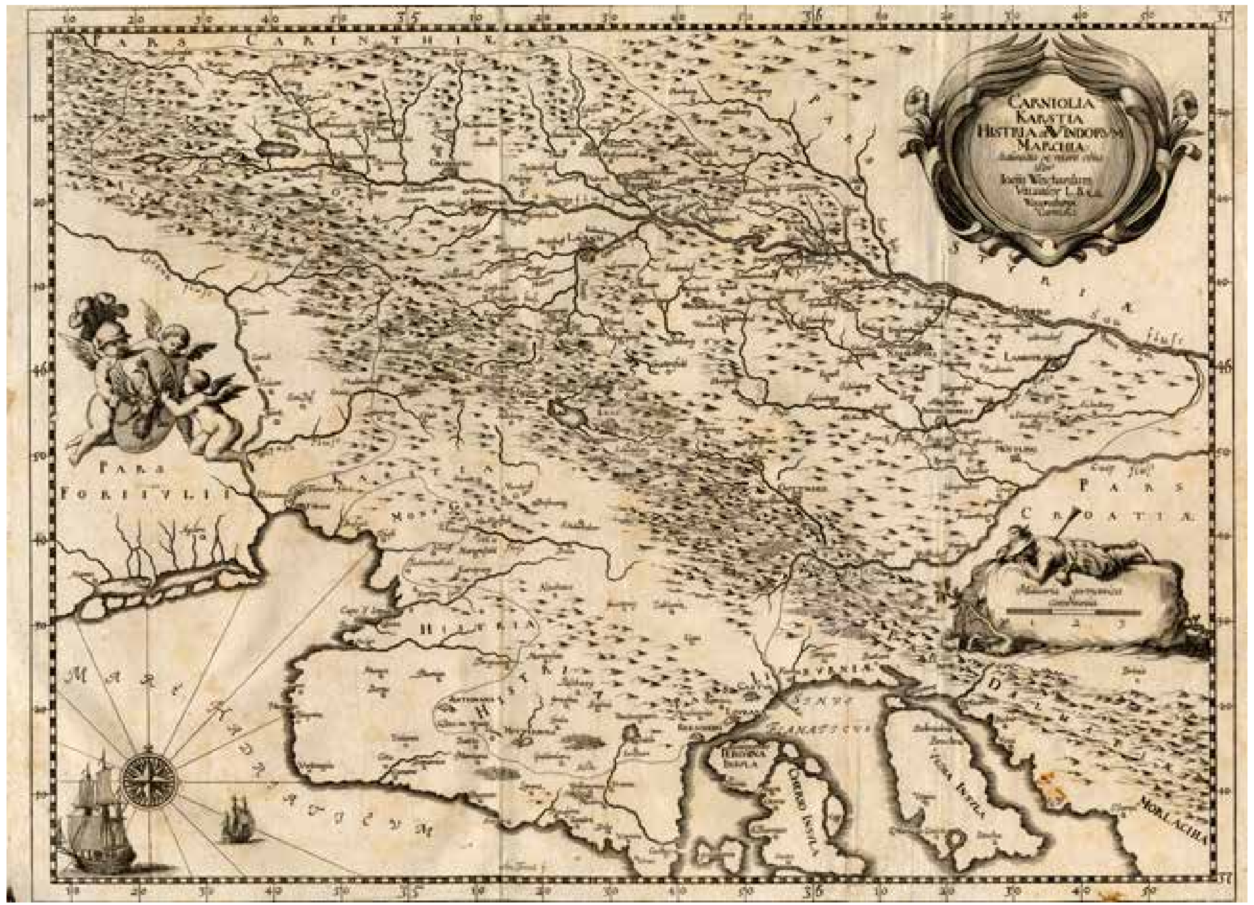
JANEZ VAJKARD VALVASOR (1641–1693), A NOBLEMAN OF CARNIOLA, POLYHISTOR, MEMBER OF THE ROYAL SOCIETY OF LONDON

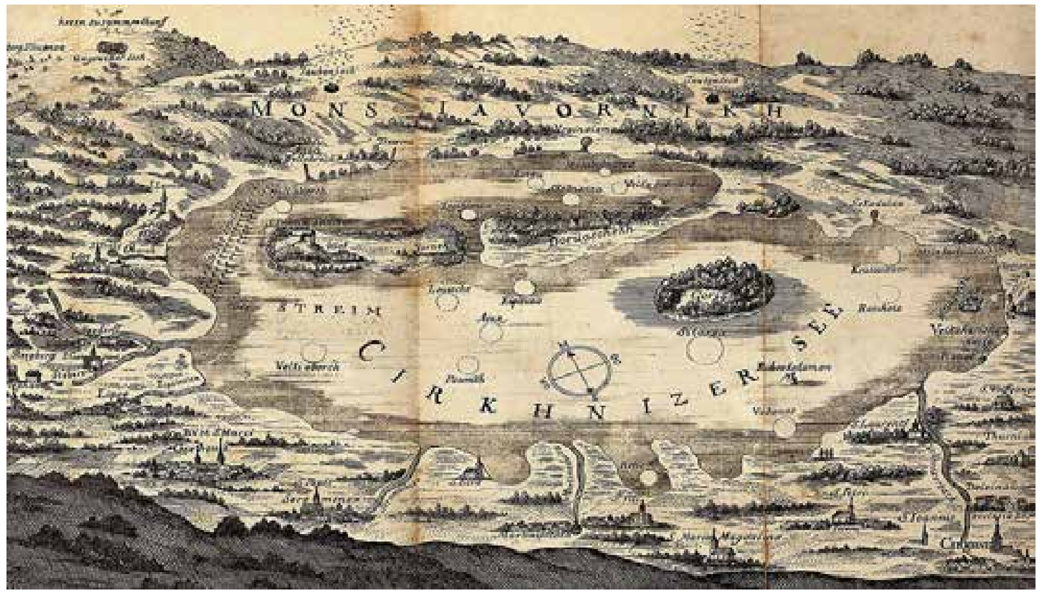
V 17. stoletju so se ob tujih avtorjih zemljevidov in geografskih raziskav uveljavili tudi prvi ustvarjalci, ki so živeli na območju današnje Slovenije. Med njimi pripada posebno mesto Janezu Vajkardu Valvasorju, potopiscu, zgodovinarju in kartografu. Čeprav je bil po poklicu vojak, je večino svojega življenja posvetil znanosti, zbirateljstvu in preučevanju Kranjske.

In the 17th century, the first authors of maps and geographic surveys living in the modern-day Slovenia became established alongside their foreign colleagues. A special place belongs to Janez Vajkard Valvasor, a travel writer, historian and cartographer. A soldier by profession, he dedicated most of his life to science, collecting and the study of Carniola.

S pomočjo rezultatov terenskih meritev je Valvasor izboljšal Merianov in Mercatorjev zemljevid naših dežel ter ga v različni izvedbi leta 1681 objavil v Schönlebnovi kroniki *Carniolia antiqua et nova*, leta 1689 pa v *Slavi Vojvodine Kranjske.*

Applying the results of field surveys, Valvasor improved the Merian and Mercator map of our lands, publishing it in different versions in Schönleben's chronicle *Carniolia antiqua et nova* (1681), and in 1689, in his *Glory of the Duchy of Carniola.*





Valvasorjev prikaz Cerkniškega jezera, 1689.

Valvasor's depiction of Lake Cerknica, 1689.

»Veselje imam do vseh ved in umetelnosti, tako mehaničnih kakor tudi drugih, najbolj pa do matematičnih. Naredil sem tudi geografsko karto vojvodine Kranjske, prav tako kraljestva Hrvaške, ki ju vse doslej nihče ni dobro napravil ali premeril, naredil sem tudi topografijo vojvodine Kranjske z več kot tristo v baker vrezanimi podobami, pa topografijo nadvojvodine Koroške z več kot dvesto, kar vse sem sam zrisal in dal vrezati v baker na svojem gradu, imenovanem Bogenšperk.«
Iz prvega pisma J. V. Valvasorja tajniku Kraljeve družbe, 3. 12. 1685.

"I enjoy all the sciences and arts, mechanical and other, but mostly mathematics. I have made a geographical map of the Duchy of Carniola and the Kingdom of Croatia, which have never been well represented or surveyed. I have made a topography of the Duchy of Carniola with more than three hundred images from copper-engraved plates and a topography of the Duchy of Carinthia with more than two hundred, all of which I have drawn myself and had them engraved in copper at my castle, called Bogenšperk."
From the first letter of J. V. Valvasor to the Secretary of the Royal Society, 3 December 1685.

Raziskava Cerkniškega jezera pomeni enega vrhuncev Valvasorjevega znanstvenega dela. Prinesla mu je edino priznanje v življenju. Leta 1687 je bil namreč izvoljen za člana angleške Kraljeve družbe (Royal Society) v Londonu.

The study of Lake Cerknica, one of the culminations of Valvasor's scientific work, won him the only recognition of his life. In 1687, he became a Fellow of the Royal Society in London.

»Sam sem napravil risbo in po naravi postavil radovednemu bralcu pred oči jezero z vsem, kar se da videti v njem in okoli njega, po tem, ko sem kolikor mogoče vse pregledal, najmarljiveje zabeležil in zaznamenoval. Tako sem se v obeh preteklih letih 1684 in 1685 dostikrat napotil tja, ko je jezero usihalo in ko je spet prihajalo na dan, ko je bilo čisto polno in ko je bilo popolnoma usahlo ali suho. In to se je zgodilo ne le v omenjenih letih, temveč večkrat tudi nekaj let poprej. Zdi se mi, da je jezero vredno, da sem se zaradi njega toliko potrudil, ker ga imam za eno največjih naravnih čudes. Mislim, da ni najti ne v Evropi, ne v ostalih treh delih sveta tako čudovitega jezera, ki bi vsebovalo toliko redkih lastnosti, kakor to.«
J. V. Valvasor, *Die Ehre dess Herzogthums Crain*, Nürnberg 1689.

"I made the drawing true to nature myself. I placed the lake in front of the curious reader's eyes, with everything that could be seen in and around it, after I had examined everything as much as possible, recorded and marked it as clearly as I could. Thus, in both 1684 and 1685, I often went there when the lake was drying up and resurfacing, when it was filled and when it was completely dry or disappeared. And this happened not only in the years mentioned but also several times before. I believe the lake is worth the effort I have made because I consider it one of the greatest natural wonders. I do not think there is a lake as beautiful in Europe or the other three corners of the world that would have as many rare features as this one".
J. V. Valvasor, *Die Ehre dess Herzogthums Crain*, Nürnberg 1689.

Valvasor se je zavedal pomembnosti prometne povezave med Kranjsko in ostalimi severnimi deželami. Leta 1575 je bil tik pod vrhom prelaza Ljubelj zgrajen krajši predor dolžine 100 m, ki je bil v zimskem času večkrat zaprt. Veljal je za najbolj strm cestni prelaz na celotnem področju Alp, saj je naklon na gorenjski strani povprečno 14 %, na nekaterih mestih pa celo 32 %.

Njegov načrt gradnje novega, daljšega predora je bil udejanjen šele leta 1964.

Valvasor appreciated the importance of transport connection between Carniola and the provinces up north. In 1575, a 100-metre-long tunnel was built just below the top of the Ljubelj (Loibl) Pass, which was often impassable during the winter. Ljubelj was considered the steepest road pass in the Alpine region, with an average gradient of 14% on the Slovene side and 32% in some places.

It took nearly four centuries to build a new, longer tunnel in 1964.

Runk F., cesta čez Ljubeljski prelaz s kranjske strani, 1815.
Runk F., The road over the Ljubelj Pass from the direction of Kranj, 1815.

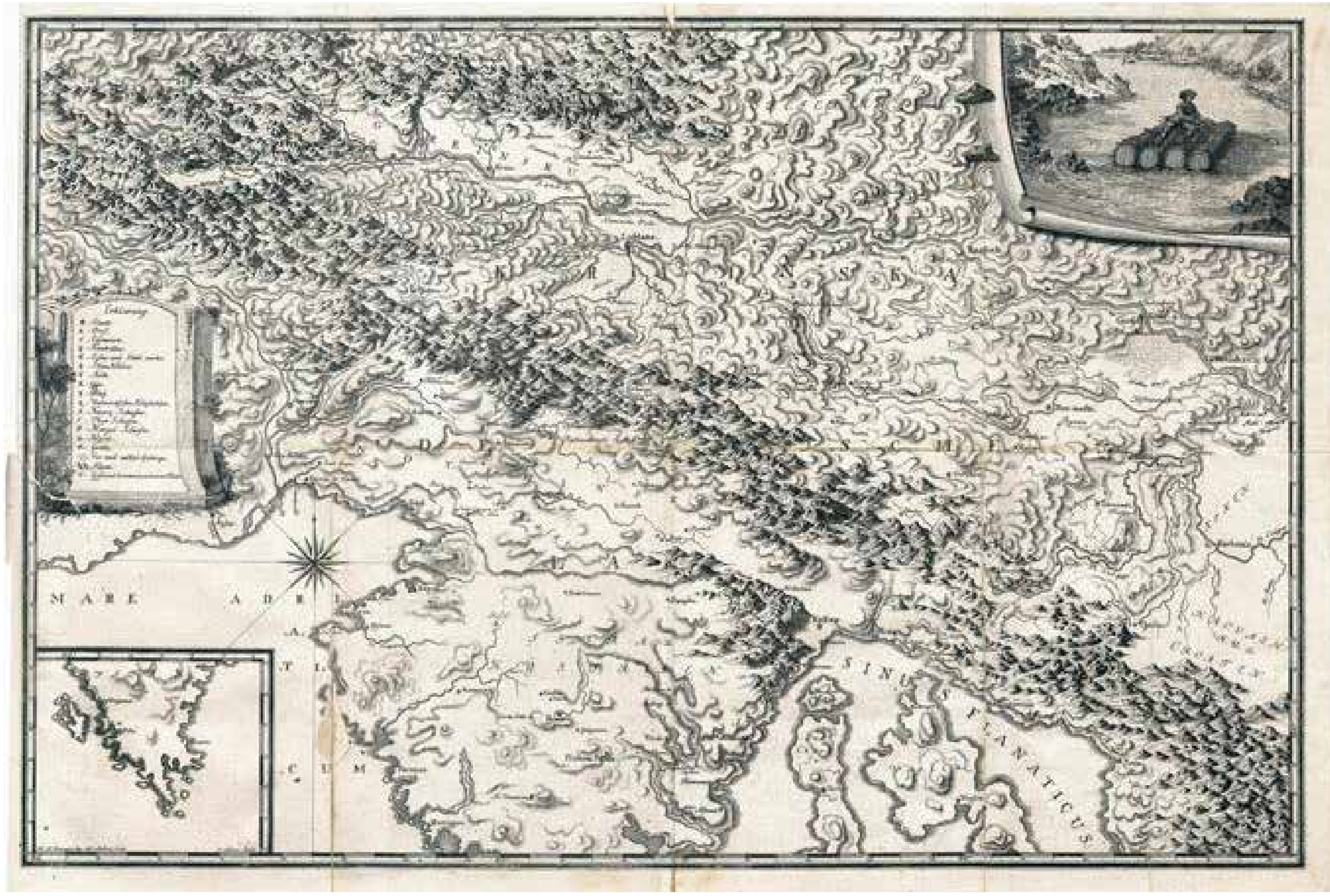
6.4 PRVE KARTE S SLOVENSKIMI IMENI

FIRST MAPS WITH SLOVENE NAMES

Zaradi rudnika živega srebra je Idrija v 18. stoletju postala eno od cesarskih znanstvenih središč. V letih 1766 do 1773 je v Idriji deloval kirurg in naravoslovec Baltazar Hacquet, po rodu Francoz. Približno stoletje po Valvazorju je njegovo pionirsko topografsko delo nadgradil in izdelal sloviti naravoslovni in mineraloški opis tedanje Kranjske *Oryctographia Carniolica* v štirih delih. Tematsko vsebino zemljevida predstavljajo nahajališča kamnin in rudnin, ki do tedaj še niso bila kartirana in jih je Hacquet označil na osnovi lastnih opažanj in preizkusov.

In the 18th century, Idrija became one of the imperial scientific centres due to its mercury mine. Between 1766 and 1773, Balthasar Haquet, a physician and naturalist of French descent, was a surgeon in Idrija. A century or so after Valvasor, he upgraded his pioneering topographical work with *Oryctographia Carniolica*, the four-volume geological and mineralogical study of Carniola. The map represents rock and mineral deposits not mapped before, which Hacquet mapped based on his observations and testing.

Zemljevid v približnem merilu 1 : 500.000, ki prikazuje celotno Kranjsko s pokrajinskim imenom Krainska deschela.
Hacque added to the first part of the Palaeontology of Carniola a map on an approximate scale of 1:500,000, showing the whole of Carniola with the provincial name Krainska deschela.



Sredi 18. stoletja smo tudi Slovenci dobili izvirno kartografsko delo *Ducatus Carnioliae Tabula Chorographica*. Stenski zemljevid, ki je izšel leta 1744, je Ivan Dizma Florjančič de Grienfeld, župnik in cistercijanec iz Stične, izdelal v približnem merilu 1 : 100.000.

Zemljevid je sad avtorjevih desetletnih popisovanj in geodetskih meritev. Kot dokaz, da so bile njegove meritve zelo natančne, predvsem glede višin, ki so bile dotlej manj dorečene, je na rob zemljevida za najvišjo goro Kranjske zapisal: *»... dviga se navpično 1399 pariških šestkratnih čevljev nad ljubljanskim horizontom.«* Današnjo višino Triglava je torej Florjančičeva meritev presegala le za 162 m.

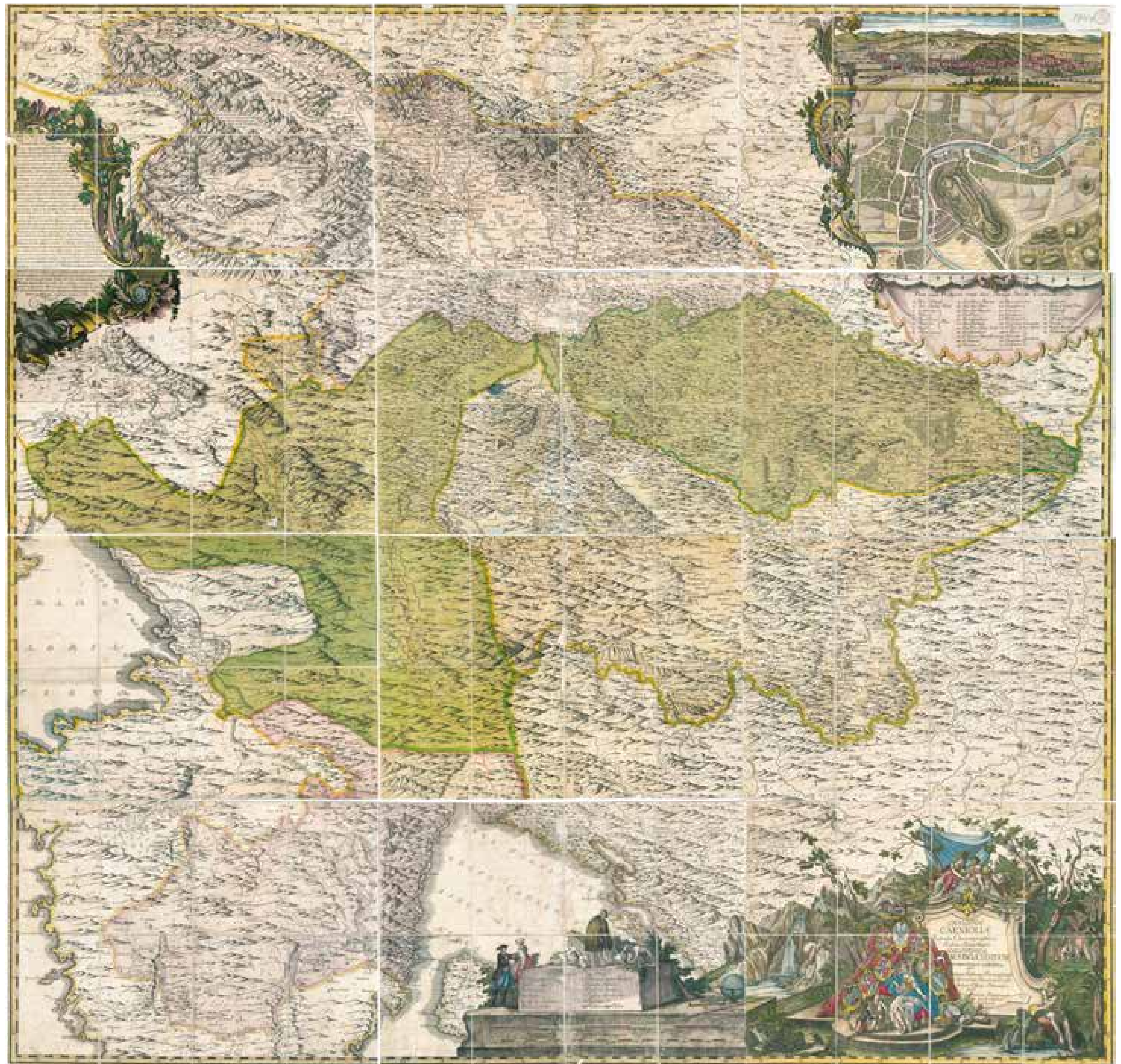
Velja omeniti, da se je na zemljevidu, namenjenem javnosti, prvič pojavilo ime naše najvišje gore v slovenščini kot Terglou.

The first original cartographic work in Slovenia is *Ducatus Carnioliae Tabula Chorographica* from the mid-18th century. A wall map publihsed in 1744 was made by Ivan Dizma Florjančič de Grienfeld, a pastor and Cistercian from Stična monastery, on an approximate scale of 1:100,000.

It is the result of the authors' decades worth of records and geodetic measurements. To vindicate the accuracy of his measurements, in particular regarding heights that were less definite at the time, he wrote on the edge of the map of the highest mountain in Carniola: *"[...] rises vertically 1399 Paris feet above the Ljubljana horizon."* Florjančič measurement was hence only 162 m above actual height of Triglav.

On a map intended for the public, the name of our highest mountain is written for the first time in Slovene – Terglou.

Horografska karta Vojvodine Kranjske, 1744.
Chorographic map of the Duchy of Carniola, 1744.

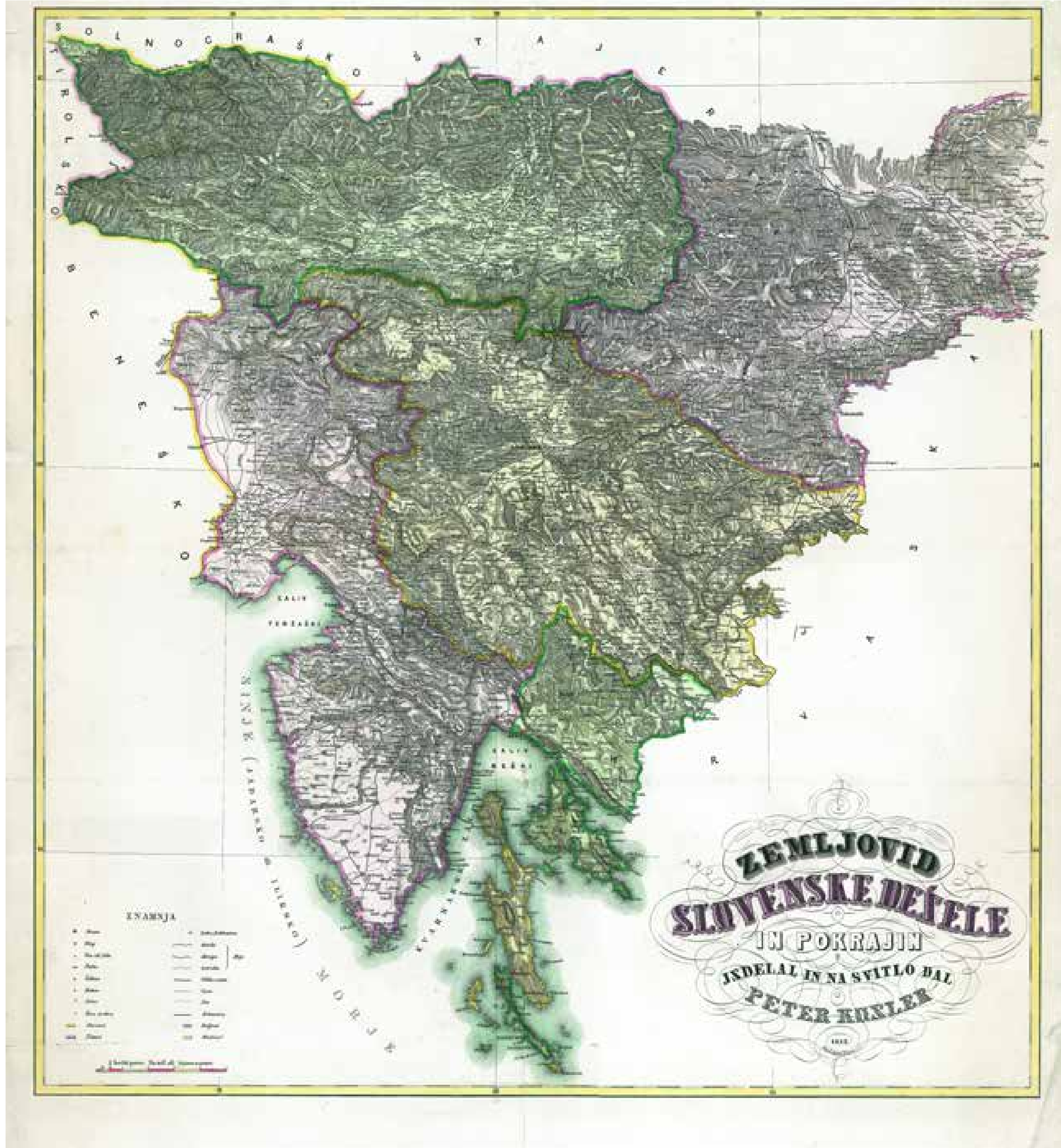


Mejo slovenskega etničnega ozemlja je na zemljevid v merilu 1 : 576.000 prvi začrtal Peter Kozler leta 1853, čeprav Slovenija administrativno še ni obstajala. Peter Kozler je kot pravnik in politik želel z *Zemljovidom Slovenske dežele in pokrajin* jasno predstaviti idejo programa Zedinjene Slovenije in z njim povezane zahteve po rabi narodnega jezika. Zaradi izrazito propagandne vsebine je bil zemljevid takoj ob izidu zaplenjen z obrazložitvijo, da že z naslovom ruši zakonito zvezo avstrijskih dežel.

V javnosti se je pojavil osem let kasneje. V relativno kratkem času je doživel dva ponatisa, in sicer leta 1864 in 1871.

The borders of the Slovene ethnic territory were first drawn on a 1:576,000 scale map by Peter Kozler in 1853, although at the time Slovenia was not yet an administrative unit. With his *Map of the Slovene Land and Provinces*, Peter Kozler, a lawyer and politician, wanted to make solid ground for the presentation of the United Slovenia programme and the associated demands for equal rights of the national language in public. Due to its explicit propaganda content, the map was confiscated upon its publication, arguing that its very title destroys the legal union of the Austrian provinces.

The map emerged in public eight years later. It ran two reprints in a relatively short time, in 1864 and 1871.



6.5 DOSEŽKI SLOVENSKE KARTOGRAFIJE

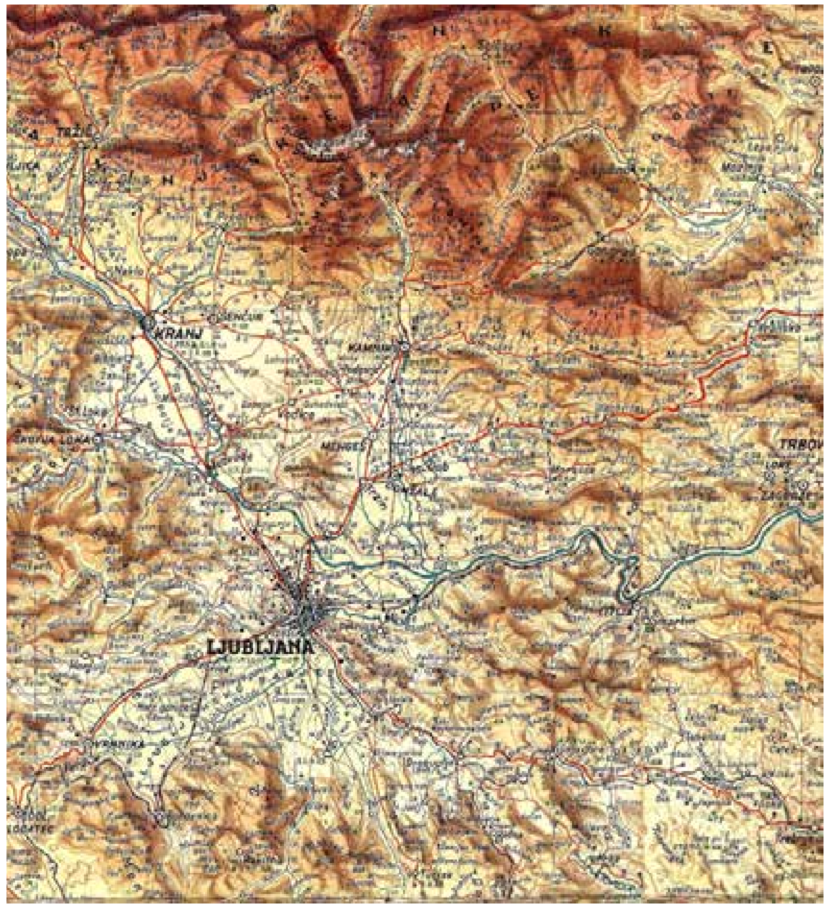
ACCOMPLISHMENTS OF SLOVENE CARTOGRAPHY

Poleg mnogih znanih evropskih kartografov, ki so pogosto prikazovali območje današnje Slovenije na svojih kartah, so tudi slovenski kartografi prispevali pomemben delež s svojimi kartografskimi deli ali prispevki:

- Janez Vajkard Valvazor (1641-1693) s temeljitim topografskim opisom in kartografskim prikazom dežele Kranjske (1689),
- Anton Steinberg (1684-1765) s tematskimi cestnimi in rudniško-jamskimi kartami,
- Ivan Dizma Florjančič de Grienfeld (1691-1757) z izredno podrobnim kartografskim prikazom Kranjske (1744),
- Peter Kozler, ki je s svojim *»Zemljovidom«* podprl narodnobuditeljske težnje,
- Blaž Kocen (1821-1871) in Ivan Selan (1902-1981) pa z izjemnim občutkom in talentom s svojimi šolskimi kartami.

In addition to the many well-known European cartographers who often depicted the area of present-day Slovenia on maps, the contribution of Slovenian cartographers is also important:

- Janez Vajkard Valvazor (1641-1693) with a thorough topographical description and cartographic representation of the land of Carniola – Map of the Duchy of Carniola (1689),
- Anton Steinberg (1684-1765) with thematic road and mine-pit maps,
- Ivan Dizma Florjančič de Grienfeld (1691-1757) with a highly detailed cartographic representation of Carniola - Chorographic Map of the Duchy of Carniola (1744),
- Peter Kozler (1824-1879), whose *Zemljovid* supported national awakening tendencies,
- Blaž Kocen (1821-1871) and Ivan Selan (1902-1981) created school maps with exceptional flair and talent.



Izsek iz zemljevida Slovenije in sosednjih pokrajin v merilu 1 : 300.000. Je prvi Selanov zemljevid Slovenije za turistično in tudi šolsko rabo, izdelan leta 1952.

A detail from a map of Slovenia and neighbouring provinces at a scale of 1:300,000. It is the first Selan's map of Slovenia for tourist and school use, produced in 1952.

Karta 47 iz Kocenovega atlasa, 1914.

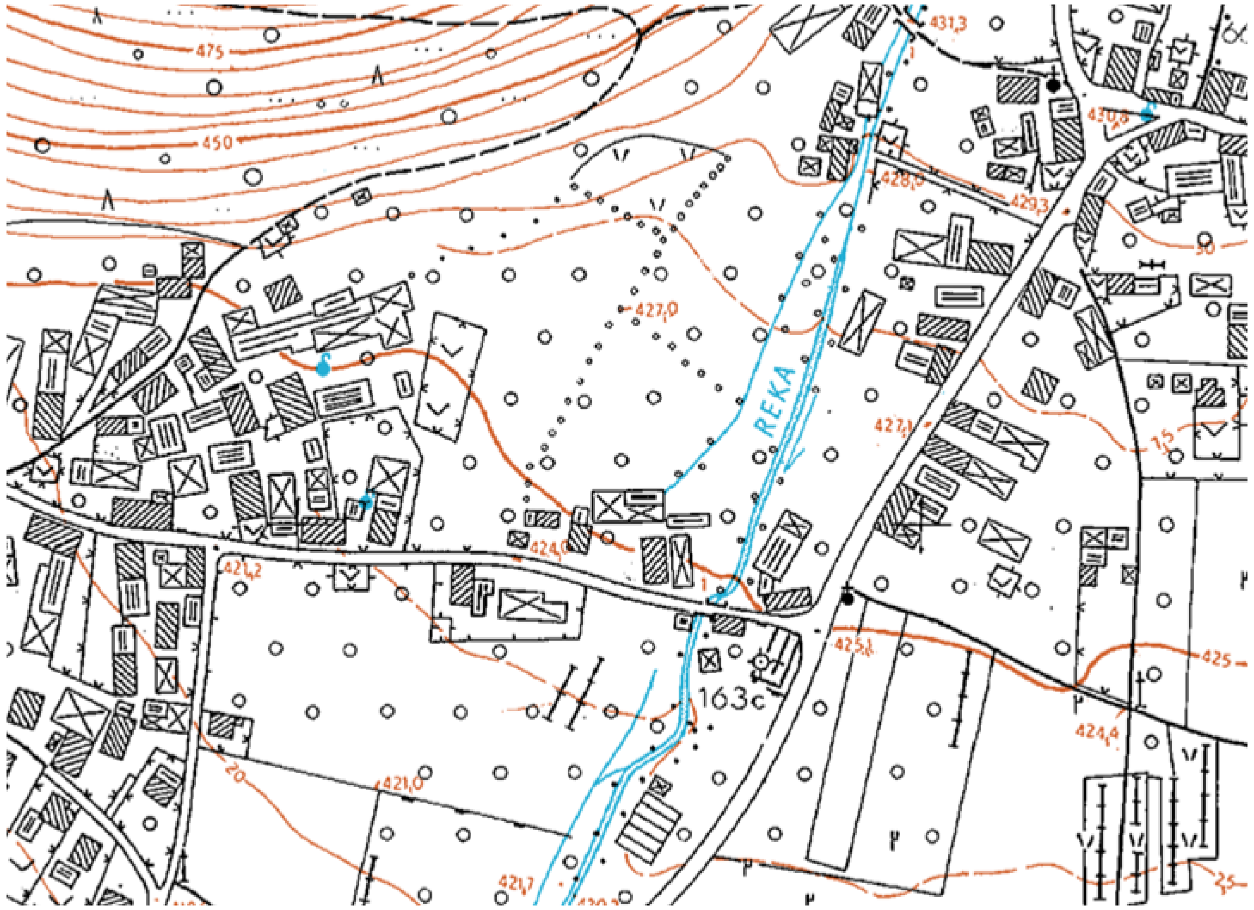
Map 47 from Kocen's atlas, 1914.

Prvi velik dosežek slovenske institucionalne kartografije predstavlja izdelava Temeljnega topografskega načrta (TTN) – podrobne kartografske pokritosti celotnega ozemlja Slovenije, po osamosvojitvi pa izdelava Državne topografske karte DTK 50.

The significant achievements of Slovene institutional cartography are the production of the Basic Topographic Map (TTN) and the National Topographic Maps DTK 50.

Temeljni topografski načrt TTN – podrobna kartografska pokritost celotnega ozemlja Slovenije (Geodetska uprava Republike Slovenije).

Basic Topographic Map TTN – detailed cartographic coverage of the entire territory of Slovenia (Surveying and Mapping Authority of the Republic of Slovenia).

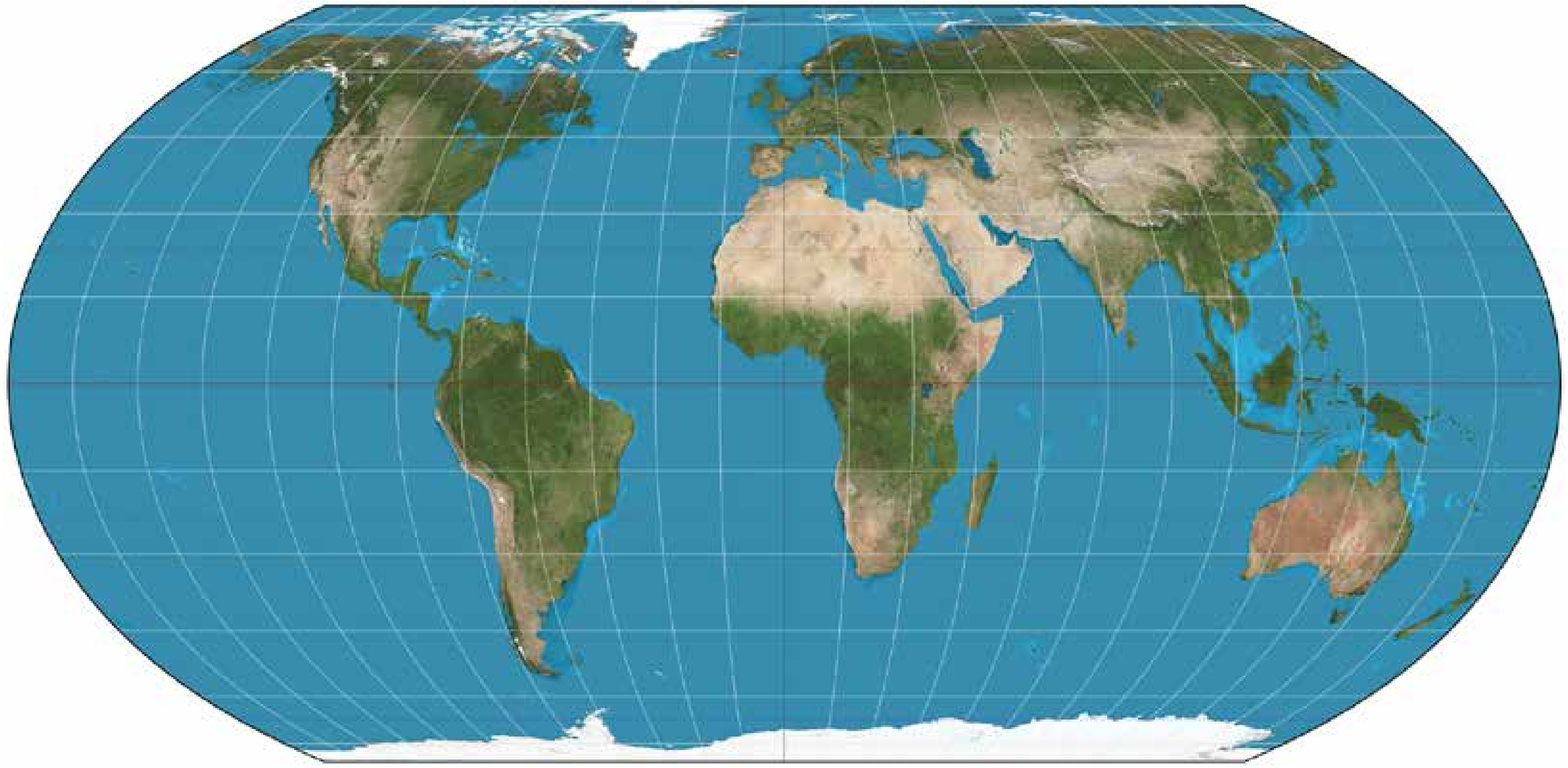


V zadnjih dvajsetih letih so bile na mednarodnih kartografskih razstavah nagrajene mestna karta Maribor, taktilna karta (za slepe in slabovidne), letalska navigacijska karta ter planinska karta Bohinja, ki sodi v skupino najbolj priljubljenih kart v Sloveniji.

Naš rojak Bojan Šavrič je soavtor ene najbolj »optimalnih« kartografskih projekcij za prikaz sveta, ki skuša kljub neizogibnim popačenjem čim bolj verodostojno prikazati podobo našega planeta.

In the last twenty years, the city map of Maribor, the tactile map (for the blind and visually impaired), the aeronautical navigation map and the mountain map of Bohinj, one of the most popular maps in Slovenia, have been awarded at international cartographic exhibitions.

Our countryman Bojan Šavrič co-authored one of the most "optimal" projections for the world map, which, despite the inevitable distortions, attempts to allow as a faithful representation of our planet as possible.



Nova »optimalna« kartografska projekcija B. Šavriča.
Equal Earth cartographic projection co-authored by Bojan Šavrič.

7 ZEMLJIŠKI KATASTER / LAND CADASTRE

7.1 GRAFIČNI KATASTER

GRAPHICAL LAND CADASTRE

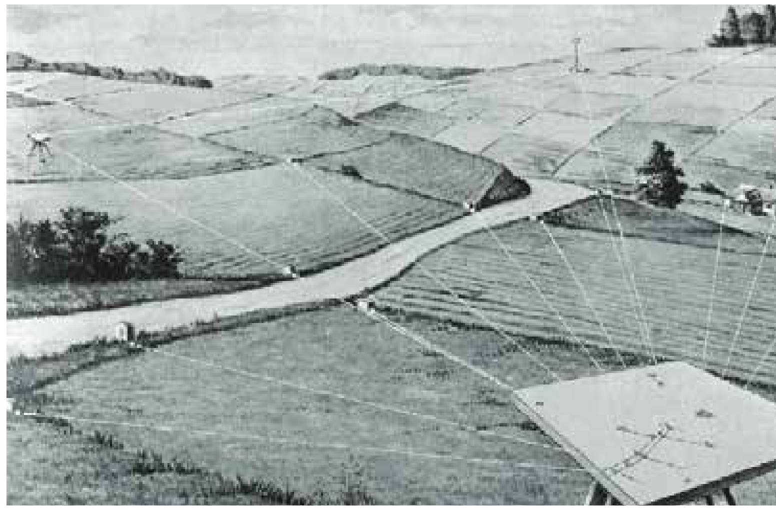
Vojaška triangulacija.
Military triangulation.

Grafični zemljiški kataster sloni na predhodno izvedeni triangulaciji, tj. geodetsko določeni mreži trikotnikov, ki sega v leta 1806 do 1811.

Katastrska triangulacija višjih redov se je izvajala v letih 1820–22. Poznejša analiza je pokazala, da je bila kakovost takratne triangulacije neenakomerna in, v celoti gledano, bistveno slabša v primerjavi z mrežami, ki so začele nastajati proti koncu 19. stoletja.

Graphical land cadastre is based on pre-emptive triangulation, i.e., a trigonometric network from 1806 to 1811.

A higher-order cadastral triangulation was implemented in 1820-22. Subsequent analysis showed that its quality varied significantly and was way inferior to the networks that began to emerge in the late 19th century.



Na osnovi Zakona o zemljiškem davku iz leta 1817 se v vseh deželah takratne Avstro-Ogrske monarhije postavijo temelji katastrskega sistema.

Izmera Slovenske dežele je bila izvedena v obdobju 1818 do 1828 (Prekmurje 1856 do 1867).

Originalna katastrska mapa je grafični zaris zemljišč, ki ga je geometer izdelal ob merjenju na terenu. Mapni list je bil ob merjenju prilepljen na mersko mizico z jajčnim beljakom, kar je zagotavljalo njegovo nepremičnost na mizici ob merjenju oziroma zajemanju parcel na mapni list.

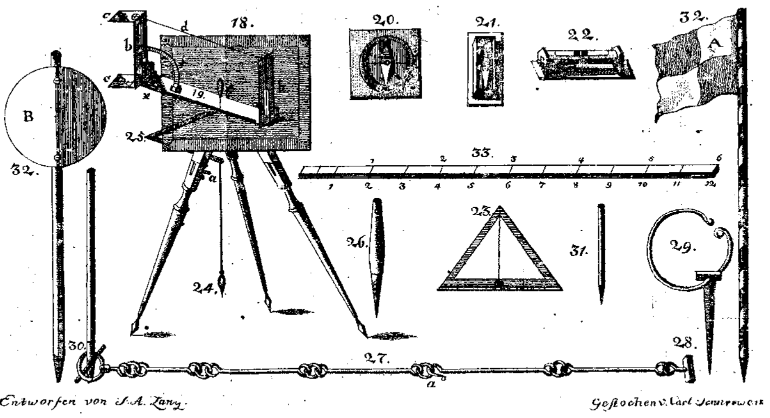
The Land Tax Act of 1817 laid the foundations of the cadastral system for the entire Austro-Hungarian Monarchy.

The survey of the Slovene land was performed in the period from 1818 to 1828 (Prekmurje 1856 to 1867).

The original cadastral plan is a graphical outline of the land made by the surveyor during field measurement. Each map sheet was pasted with egg white onto the plane table during measurement to ensure its immobility while measuring or recording parcels.

Indikacijska skica KO Gutenstein (danes Ravne) je bila izdelana na terenu. Z razliko od kasnejših zemljiškokatastrskih načrtov vsebuje tudi atributne (opisne) podatke o nepremičninah (npr. lastniki, hišne številke, oznake za pošto, cerkev, vrsta rabe zemljišča je prikazana z barvo). Ko je zaradi številnih sprememb postala nepregledna ali se je poškodovala, so jo prerisali na nov nosilec.

Indication sketch KO Gutenstein, today's Ravne, was produced in the field. Contrary to later land cadastre plans, it contains attribute (descriptive) data on real estate (such as the owners, house number, markings for a post office, church, use of land is colour-coded). When the sketch was damaged or became unclear due to numerous changes, it was redrawn on a new medium.

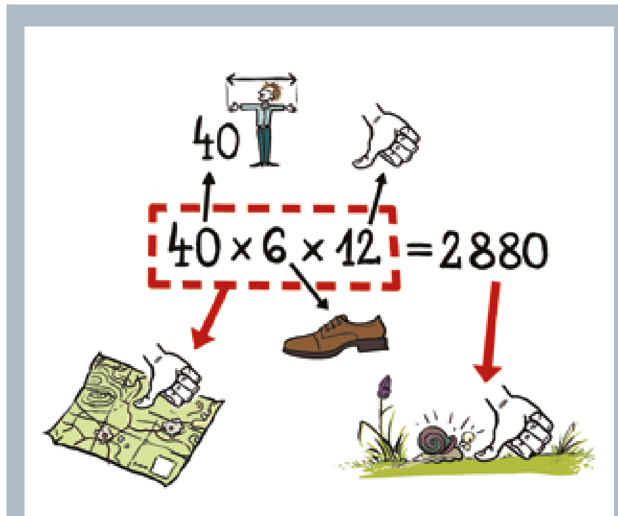


Obvezna merska oprema za detajlno izmero v prvi polovici 19. stoletja in pozneje tudi pri reambulaciji grafičnega katastra: merska mizica, libela, dioptrsko ravnilo, svinčnica, 10 col dolga merska veriga in risalni pribor.

Essential equipment for detailed surveying in the first half of the 19th century and later in the revision of the graphical cadastre (plane table, spirit level, dioptre, plummet, 10-inch-long measuring chain and drawing accessories).

V letih 1867 do 1869 so bile opravljene reambulacija trigonometrične mreže in domeritve prvotne grafične izmere. Spremembe, ugotovljene z revizijo izmere, so se z rdečim tušem vrisale v načrte prvotne izmere, ob končanem vrisu pa so bili izdelani novi odtisi načrtov.

Between 1867 and 1869, the trigonometric grid was revised and the original graphical measurements were updated. The changes detected in the survey revision were entered in the original survey maps in red ink and new map prints were produced.



1 : 2880 - merilo prvih katastrskih načrtov
Merilo izhaja iz sežnjskega sistema, kar pomeni, da je 1 palec na načrtu = 40 sežnjev (1 : 40).
1 sežnj = 6 čevljev
1 čevelj = 12 palcev
Palec na načrtu je torej 2880 palcev v naravi (40 x 6 x 12).

1:2880 – scale of the first cadastral maps
The scale derives from the fathom system, meaning one inch on the map = 40 fathoms in nature.
1 fathom = 6 feet
1 foot = 12 inches
Therefore, an inch on the map is equal to 40 x 6 x 12 = 2880 inches in nature.

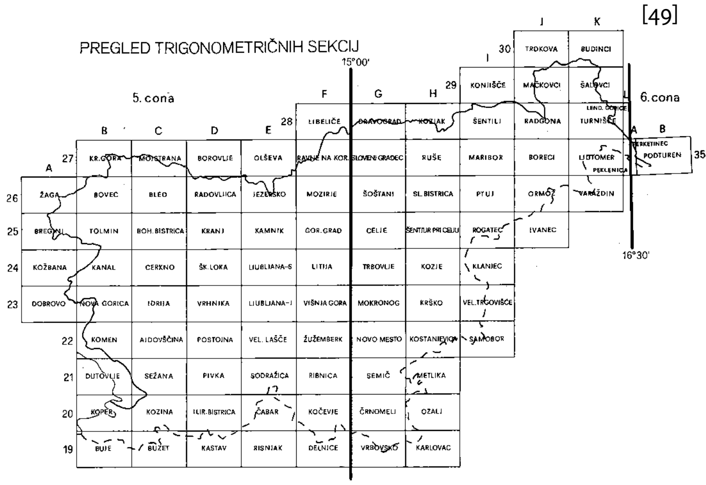
7.2 NUMERIČNI KATASTER

NUMERICAL CADASTRE

Novi katastrski predpisi, uveljavljeni po letu 1896, so naložili sprotno evidentiranje sprememb in s tem dopolnili določila zakona iz leta 1883, ki je predvideval evidenco sprememb le z revizijo.

Leta 1839 je na Dunaju ustanovljeni Vojaški geografski inštitut začel dolgotrajno obnovo trigonometrične mreže 1. reda v celotni državi. Naše ozemlje je prišlo na vrsto v zadnjih desetletjih 19. stoletja.

Kraljevina SHS je sprejela obnovljeno trigonometrično mrežo kot horizontalno podlago za vse potrebe geodezije v državi. Vpeljana je bila tudi Gauß-Krügerjeva projekcija v treh meridianskih conah z osmi 15°, 18° in 21° vzhodno od Greenwicha.



Na predlog Vladimirja Globočnika pl. Sorodolskega - slovenskega pravnika, je tedanja Avstrija leta 1909 začela izvajati triangulacijska dela, kjer je bila podlaga Gaußova konformna projekcija.

Po drugi svetovni vojni se je na podlagi razvijanja triangulacijske mreže 2. in 3. reda in določenih domeritvah na triangulaciji 1. reda vzpostavil koordinatni sistem, ki mu pravimo D48 (še danes v uporabi).

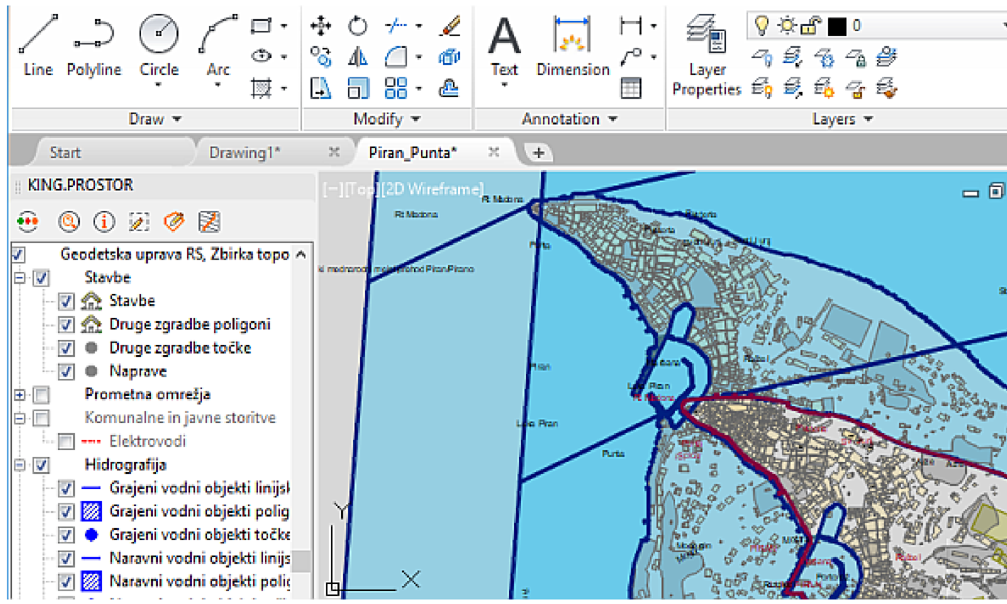
The new cadastral regulations, which came into force after 1896, stipulated that changes should be recorded in real-time, thus supplementing the provisions of the 1883 act, according to which changes had to be recorded only upon revision.

In 1839, the Vienna-based Military Geographical Institute launched a lengthy restoration of the first-order trigonometric network throughout the country. Our territory got its turn in the last decades of the 19th century.

The Kingdom of Serbs, Croats and Slovenes adopted the restored network, using it as horizontal control in state and cadastral surveying. They also accepted the Gauß-Krüger projection of meridian zones. The Kingdom was divided into three zones with their middle meridians at 15°, 18° and 21° longitude east of Greenwich.

Following the suggestion of Slovene lawyer Vladimir Globočnik pl. Sorodolski, the then Austria initiated triangulation work in 1909 based on the Gauß Conformal Projection, providing the triangulation works with a solid mathematical and cartographic basis.

After World War Two, the second and third-order triangulation network and some additional measurements on the first-order triangulation were the foundations for establishing the D48/GK coordinate system (still in use today).



Piran v D48 in D96.

Piran in D48 and D96.

Od leta 2008 je v Sloveniji za meritve v zemljiškem katastru v uporabi nov koordinatni sistem (D96).

Since 2008, a new coordinate system (D96) has been used in Slovenia for land cadastre surveying.

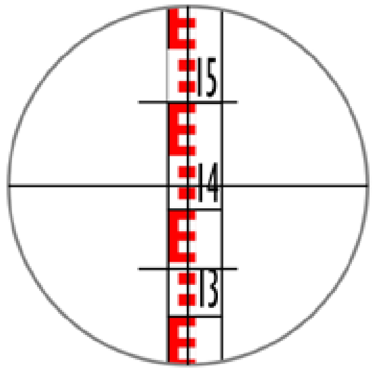
Numerični katastrski načrti so se izdelovali v merilih 1 : 500, 1 : 1.000, 1 : 2.000 in 1 : 2.500, ki izhajajo iz metrskega sistema. Na podlagi merskih podatkov so bili z ročnim kartiranjem izdelani analogni katastrski načrti. Grafični izris katastrskih načrtov je bil torej izdelan s kartiranjem numeričnih merskih podatkov.

Numerical cadastral maps produced in scales of 1:500, 1:1000, 1:2000 and 1:2500 are based on the metric system. Using this measurement data, analogue cadastral maps were produced by manual mapping. Hence, the graphical plot of the cadastral maps was produced by mapping the numerical measurement data.

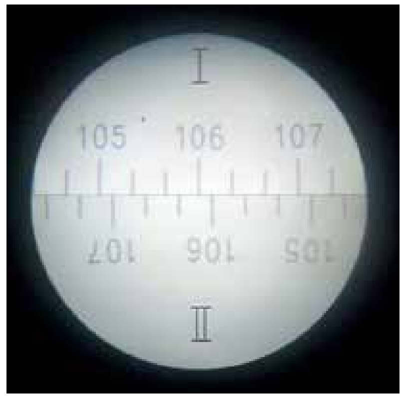
Polarna izmera za nastavitev numerično-grafičnega katastra.
Polar measurement for the establishment of the graphical numerical cadastre.

Nazadnje je bil v uporabi numerični način izmere, kar pomeni, da so bile mejne točke določene s koordinatami v veljavnem koordinatnem sistemu in tudi površine so bile določene iz koordinat.

The numerical measurement method determined the border points by coordinates in the valid coordinate system and the surface areas from the coordinates.



Optično merjenje razdalje na tahimetrični lati
(1,500 m – 1,343 m) = 0,157 m X 100 = 15,7 m.
Reading on the stadia rod
(1.500 m – 1.343 m) = 0.157 m X 100 = 15.7 m.



Vrednost vertikalnega kota je 106° 04‘.
Vertical angle of 106° 04‘.

Odčitek vrednosti horizontalnega kota s pomočjo nonija 331° 54´.
Vernier used for reading the horizontal angle 331° 54´.

Odčitek horizontalnega kota z mikrometrskim vijakom (189° 40,8‘).
Micrometer screw used for reading the horizontal angle (189° 40.8‘).

7.3 ZAČETEK IN VZPOSTAVITEV KATASTRA NA SLOVENSKEM

FORMATION OF THE LAND CADASTRE IN THE TERRITORY OF SLOVENIA

Habsburški monarhi, ki so korenito zarezali v življenje slovenskega kmeta.
Habsburg monarchs who caused a massive difference in the life of the Slovene peasant.

Marija Terezija (1717–1780): terezijanski kataster

Na območju današnje Slovenije sega nastanek zemljiškega katastra v sredino 18. stoletja, ko je v takratnih delih habsburške monarhije (Avstriji) cesarica Marija Terezija uvedla popisni kataster. Osnova za obdavčitev je zajemala kapitalski donos glede na vrsto posestva, ki se je delilo na dominikalno (gosposko) ali rustikalno (kmečko). Zemljišča niso bila izmerjena, temveč je bila njihova velikost ocenjena po povprečni količini posejanega žita, velikost travniških zemljišč je bila ocenjena po povprečnem donosu sena in otave, izraženo v eno- ali dvovpražnih vozovih, velikost gozdnih parcel pa so ocenili po količini dnevnega dela v gozdu. Terezijanski katastrski operat je bil izdelan v letih 1748 do 1756.

- Edina ženska vladarka v 650-letni zgodovini habsburške dinastije.
- Izvedla obširne reforme v vojski, sodstvu.
- Opismenila in do sitega nahranila ljudstvo (pa čeprav s krompirjem).
- Uvedla splošno davčno obveznost.
- V ta namen izvedla popis vseh zemljišč, gosposkih in kmečkih.

Maria Theresa (1717–1780): Theresian cadastre

The formation of the land cadastre for the territory of modern-day Slovenia goes back to the mid-18th century when Empress Maria Theresa introduced a census cadastre in the Habsburg Monarchy (Austria). The taxation was based on the capital yield according to the property type, classified as lordly or peasant. The land was not measured; its size was assessed by the average amount of grain sown, the size of grassland by the average yield of hay, and second cut hay quantified in hay carts (smaller, pulled by one horse) and wagons (bigger, pulled by two horses), and the size of forest plots by the amount of daily work in the forest. The Theresian cadastral record was produced between 1748 and 1756.

- The only female ruler in the 650-year history of the Habsburg dynasty.
- Promulgated extensive military and judiciary reforms.
- Increased literacy rate and saved people from famine by introducing potatoes.
- Levelled taxes on the nobility and clergy.
- To this end, she introduced a census cadastre, both of lordly and peasant land.

Jožef II. (1741–1790): jožefinski kataster

Jožef II., naslednik Marije Terezije, je dal dobrih 30 let pozneje zemljišča izmeriti, ne pa tudi izrisati. V želji, da bi uvedli enotni davčni sistem, po katerem bi bila zemlja obdavčena izključno glede na njeno plodnost, resnično rabo zemljišča in zahteve države, je v obdobju od leta 1785 do 1789 nastal katastrski operat, imenovan jožefinski kataster.

Meritev zemljišč se je opravila s predpisanim merilnim orodjem, in sicer leseno letvo in merilno verigo. Dolžina lesene letve v točni izmeri ene dunajske klaftre je morala biti razdeljena na šest enakih delov, to je šest čevljev. Merilna veriga je merila točno deset dunajskih klafter.

Če komisija, sestavljena iz kmetov, meritve ni bila sposobna opraviti, je merjenje opravil inženir, član podkomisije, njegovo izmero pa so posebej navedli v fasijo.

- Nadaljeval in radikaliziral reforme svoje predhodnice.
- Ukinil veliko cerkvenih redov in tlakoval pot svobodi veroizpovedi.
- Uvedel enotni davek.
- V ta namen izvedel enostavne izmere zemljišč, praviloma brez načrtov, v okviru katastrskih občin.

Joseph II (1741–1790): Josephine cadastre

Some 30 years later, Maria Theresa's successor Joseph II had the land measured but not mapped. In the attempt to introduce a uniform fiscal system whereby the land taxation system would be based exclusively on land's actual use, its fertility and the financial needs and requirements of the Monarchy, the so-called Josephine cadastral records, were produced between 1785 and 1789.

The land plots were measured with specified tools, comprising a wooden rod and a measuring chain. One Viennese fathom long rod had to be divided into six equal units, i.e., six feet. The measuring chain's length had to be ten Viennese fathoms sharp.

If the commission composed of peasants was not able to do the measurement, it was performed by an engineer, a member of the sub-commission, which was explicitly reported in the record.

- Further pursued and radicalised the reforms of his predecessor.
- Abolished many religious orders and paved the way for freedom of religion.
- Introduced universal tax.
- To this end, he ordered the first cadastral survey for individual cadastral communities with the primary objective to determine land plots, hence providing no or limited graphical documentation.

Franc I. (1768–1835): franciscejski kataster

23. decembra 1817 je cesar Franc I. izdal znameniti Zakon o zemljiškem davku (nem. Grundsteuerpatent), ki je s svojimi obsežnimi podzakonskimi tehničnimi in izvedbenimi predpisi tudi na Slovenskem postavil temelje katastrskega sistema za dobro stoletje, vse do izdaje starojugoslovanske katastrske in zemljiškoknjižne zakonodaje v 30. letih prejšnjega stoletja.

Novost franciscejskega katastra je bila, da so se parcele za vsako katastrsko občino v celotnem cesarstvu izmerile in izrisale v predpisanem merilu.

Nekdanji ročni sistem merjenja zemljišč je nadomestilo merjenje z merilnimi instrumenti. Merjenje so opravili šolani zemljemerci, ki so jih v ta namen pritegnili iz vojaških vrst, ter zemljemerci, ki so izšli iz vrst diplomantov Politehničnega inštituta, ustanovljenega 6. 11. 1815 na Dunaju.

- Z drugim kongresom Svete alianse leta 1821 postavil dotlej manj znano Ljubljano v središče pozornosti.
- 3. 12. 1817 izdal Zakon o zemljiškem davku.
- S tem vzpostavil stabilni zemljiški kataster.
- Parcelna številka je povezovalni atribut med grafičnim in opisnim delom katastrske evidence.
- Na območju pribl. 70 % Slovenije je ta kataster v uporabi še danes.

Francis II/I (1768–1835): Franciscan cadastre

On 23 December 1817, Emperor Francis I issued the famous Land Tax Act (Ger. Grundsteuerpatent). With its extensive technical and implementing regulations, the Act provided the foundations of the cadastral system in Slovenia for over a century until the Kingdom of Yugoslavia, of which Slovenia was part, adopted its cadastral and land registry legislation in the 1930s.

Unlike previous cadastres, each land plot for the individual cadastral community throughout the empire was measured and plotted at a determined scale.

The rods and chains previously used in land measurement were replaced by surveying instruments. Measurements were performed by trained surveyors purposefully recruited from the military and surveyors from the ranks of graduates of the Polytechnic Institute of Vienna, founded on 6 November 1815.

- The Holy Alliance's Congress of Laibach in 1821 put a relatively unknown Ljubljana in the spotlight.
- On 3 December 1817, he issued the famous Land Tax Act.
- Thereby he established a stable land cadastre.
- A parcel number is an attribute that connects the graphical and descriptive data of the cadastral record.
- This cadastre has still been used on about 70% of the Slovene territory.

Franc Jožef I. (1830–1916)

Franc Jožef I. se je rodil kot najstarejši sin nadvojvodi Francu Karlu, mlajšemu sinu avstrijskega cesarja Franca I. ‚Francek' je svojega dedka, ki je umrl tik pred njegovim petim letom, oboževal in občudoval kot idealnega vladarja.

Z izvedbo zemljiškoknjižne odveze se v času njegovega vladanja odpravi podložništvo.

Zemljiškoknjižna odveza je za geodetsko stroko pomenila poseben izziv in nemalo dela. Po reformi je namreč Avstro-Ogrska pristopila k tako imenovanemu reambulančnemu katastru.

Čeprav Franc Jožef I. s številnimi slovenskimi dosežki druge polovice 19. in začetka 20. stoletja ni bil neposredno povezan, je pa s spremembami, ki jih je odobraval, ustvaril okolje, v katerem smo lahko Slovenci postavili temelje, na katerih smo zgradili svojo kulturno in politično identiteto.

- Skupno je Slovencem vladal 68 let.
- Izvedel zemljiško odvezo, ki je pomenila odpravo podložništva.
- Enakopravnost slovenskega naroda in priznanje slovenskega jezika.
- Začel 1. svetovno vojno.

Franz Joseph I (1830–1916)

Franz Joseph I of Austria was born as the eldest son of Archduke Franz Karl, the youngest son of Francis I, the founder and emperor of the Austrian Empire. "Franzi" adored and revered his grandfather, who had died shortly before his fifth birthday, as the ideal monarch.

During his reign, the enactment of property and land use reform led to the abolition of serfdom.

The reform was a challenge and a lot of work for the surveying profession as Austro-Hungary conducted the revision of the land cadastre.

Although Franz Joseph I was not directly involved in many of the Slovene achievements of the second half of the 19th and the beginning of the 20th centuries, the changes he instigated resulted in an environment that allowed Slovenes to lay the groundwork of their cultural and political identity.

- He reigned the Slovenes for a total of 68 years.
- He enacted the agrarian reform, which effectively led to the abolition of serfdom.
- Equal rights of the Slovenes and equal status of their language.
- Started World War I.

21. decembra leta 1867 je cesar Franc Jožef podpisal Zakon o temeljnih državljanskih pravicah.

V njih je slovenski kmet, Slovenec s slovensko govorico vred proglašen za jednakopravnega državljana. Slovenec in njegov jezik je pridobil v Avstriji tiste pravice v uradih, šoli in javnem življenji, katere je užival že od nekdaj Nemec in nemški jezik. To pravico je svetli cesar Franc Jožef dne 21. decembra 1867 podpisal in proglasiti dal. Zato pa naj ne preminejo slovenskemu kmetu iz spomina trije cesarji: Maksimilijan, Ferdinand in Franc Jožef. Prvi je zatrl sužanstvo, drugi podložništvo s tlako in desetino, tretji pa povzdignil slovenskega kmeta do časti v sem drugim jednakopravnega državljana. Večna hvala in slava jim!
Vir: *Politična zgodovina Štajerskih Slovencev*, Ivan Lapajne, 1884.

On 21 December 1867, Emperor Franz Joseph signed the Fundamental Law Concerning the General Rights of Citizens.

This law guarantees Slovene peasants and Slovene people equal rights as other citizens and the use of the Slovene language in public. The Slovene people and language in Austria thereby acquired all the rights in offices, school and public life enjoyed by the German people and language forever. The great Emperor Franz Joseph signed and proclaimed this right on 21 December 1867. Therefore, may the names of three Emperors never pass from the memory of the Slovene peasant: Maximilian, Ferdinand and Franz Joseph. The first abolished slavery, the second ended serfdom with forced labour and tithes, and the third granted the Slovene peasant the privilege of equal citizenship. Eternal thanks and glory to them!
Source: *The Political History of Styrian Slovenes*, Ivan Lapajne, 1884.

7.4 OD ANALOGNEGA DO DIGITALNEGA KATASTRA

FROM ANALOGUE TO DIGITAL CADASTRE


SEZNAM PARCEL

Seznam parcel, vodenih v analognem katastrskem operatu.
List of parcels kept in the analogue cadastral record.

Zemljiški kataster je uradna evidenca zemljišč, osnovna enota je parcela.

Za vsako parcelo se vodi:

- parcelna številka,
- meja,
- površina,
- lastnik,
- upravljavec državnega ali lokalnega premoženja,
- dejanska raba,
- zemljišče pod stavbo,
- boniteta zemljišč.

Analogni kataster je bil sestavljen iz opisnega in grafičnega dela.

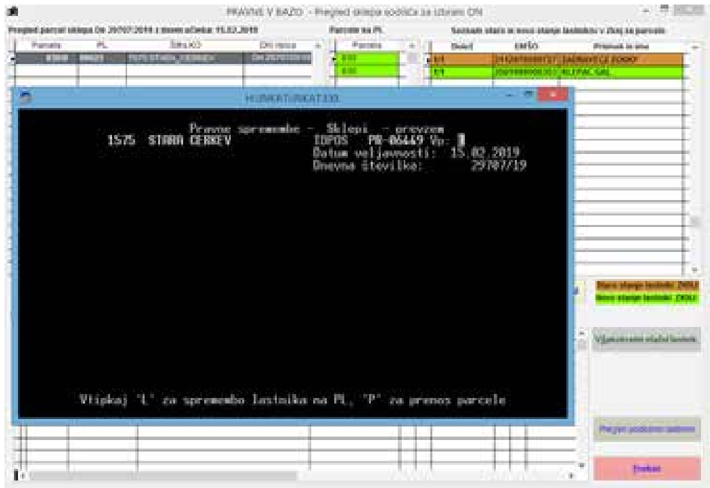
The land cadastre is the official record where land is defined by parcels.

The record of each parcel contains the following data:

- parcel number,
- border,
- surface area,
- owner,
- manager of state or local communities' property,
- land cover,
- land underneath building,
- land quality rating.

The analogue land cadastre was composed of descriptive and graphical data.

Katastrski načrt v merilu 1 : 2880.
Cadastral map in the scale of 1:2880.



S pojavom prvih osebnih računalnikov so se začele pojavljati tudi prve aplikacije za vodenje zemljiškega katastra. Leta 1991 je bil objavljen katalog osnovnih standardov podatkov, ki jih je treba voditi v zemljiškem katastru.

With the emergence of personal computers, the first applications for land cadastre management were developed. The Catalogue of basic standards of data to be kept in the land cadastre was published in 1991.

Opisni podatki zemljiškega katastra, zapis v digitalnem mediju (vir: PP INKAT)
Descriptive data of the land cadastre in the digital format (source: PP INKAT).

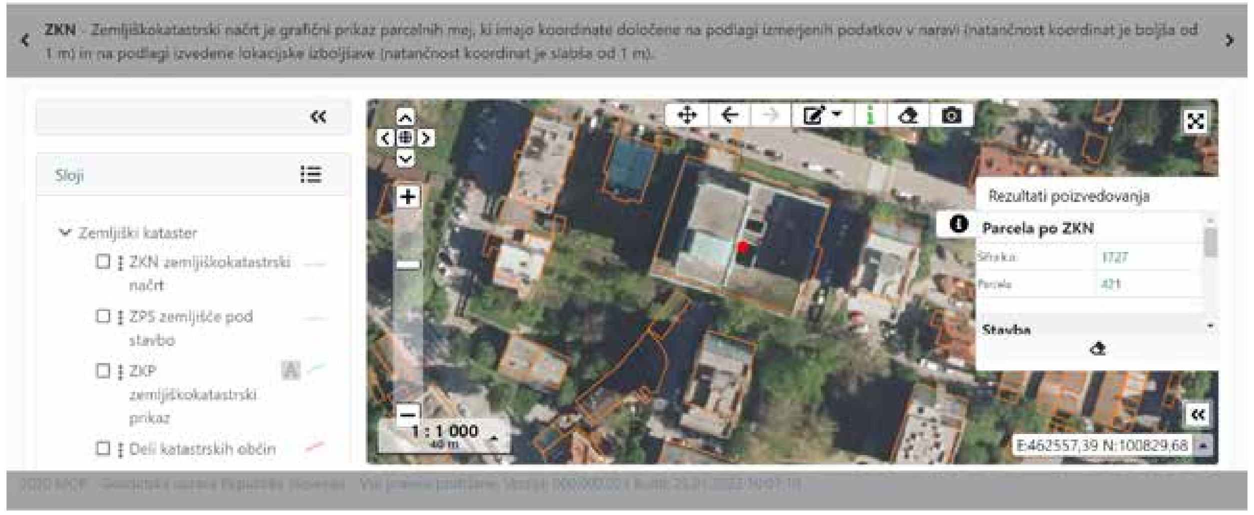
Informatizaciji opisnih podatkov zemljiškega katastra je sledila digitalizacija njegovega grafičnega dela. Načrti so bili skenirani, vektorizirani in geolocirani in nato združeni v zvezni sloj. Leta 2009 je bila digitalizirana še zadnja katastrska občina v državi.

The computerization of descriptive data in the land cadastre was followed by the digitization of the cadastre's graphical data. Maps were scanned, vectorised, geolocated, and merged in a uniform layer. The last cadastral municipality in the country was digitized in 2009.

Digitalizirani katastrski načrt.
Digitized cadastral map.

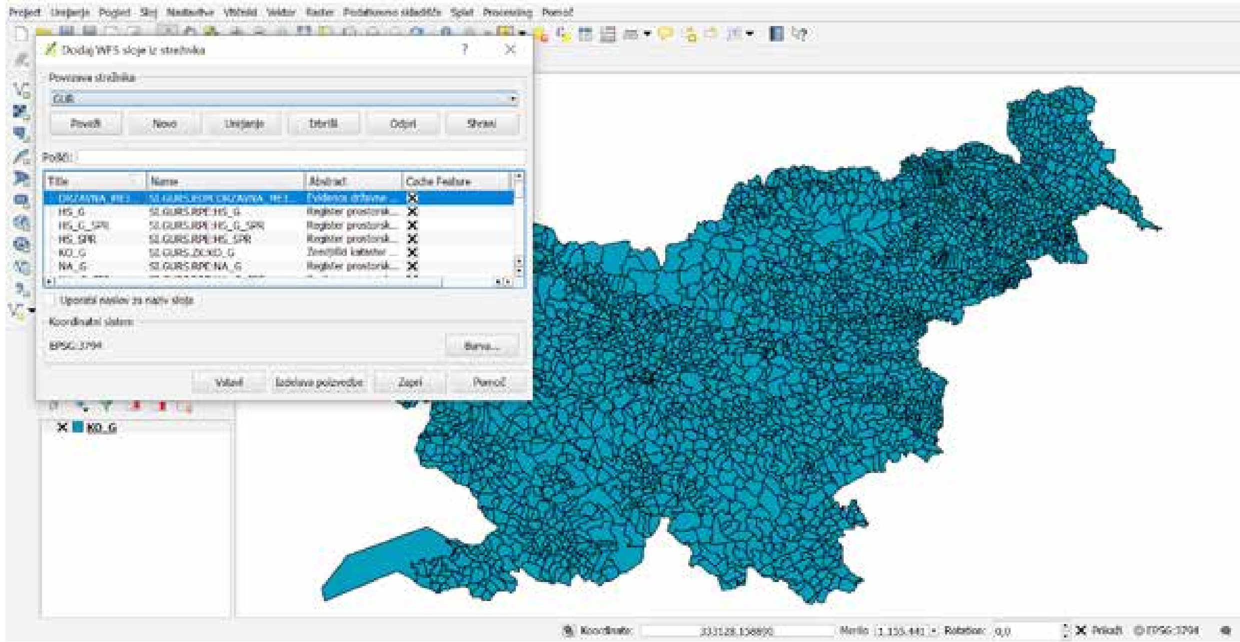
Danes so skoraj vsi podatki iz geodetskih evidenc (razen podatkov o lastniku – fizične osebe) brezplačni in prosto dostopni vsem uporabnikom. Na voljo so različni vpogledovalniki v evidence in aplikacije za prevzem geodetskih podatkov (e-Geodetski podatki). Uporabniki lahko dostopajo do podatkov tudi prek spletnih servisov.

Today, almost all data (except the data on the owner – a natural person) from the geodetic records are free of charge and accessible to all users. Various record viewers and applications for downloading geodetic data (e-Geodetic Data) are available. Users can also access the data via web services.



Uporaba spletnega servisa za prevzem podatkov o katastrskih občinah v geografskem informacijskem sistemu (Geograpgic Information System – GIS).
Web service used to retrieve data on the cadastral municipality in the geographic information system (GIS).

Javni vpogled v podatke Geodetske uprave.
Public access to the Surveying and Mapping Authority records.



Pregledovalnik arhivskih zemljiških katastrskih načrtov.
Archive land cadastre map viewer.

7.5 LASTNINA, NEPREMIČNINE, ZEMLJIŠČA, STAVBE

PROPERTY, REAL ESTATE, LAND, BUILDINGS

Geodet obvladuje znanja in veščine za merjenje in kartiranje »Zemlje in neba« z raznovrstnimi geodetskimi instrumenti in opremo.

Pravico do nepremičnine je mogoče pridobiti na podlagi verodostojne listine, ki poleg lastništva izkazuje tudi lego, obliko in velikost nepremičnine.

Osnova so kartografski prikazi in numerični podatki o nepremičnini, postavljeni pred 200 leti.

Takratni cilj izmere je bil, da se skladno s sprejetimi predpisi izdela zanesljiv kataster zemljišč, ki bi zagotavljal pravično obdavčitev kmetijske proizvodnje. Vsaki posesti so bile določene tudi fizične lastnosti zemljišč. Povezava grafičnih in opisnih podatkov ter lastnosti v sistem katastra zemljišč je omogočala trden temelj za obdavčitev.

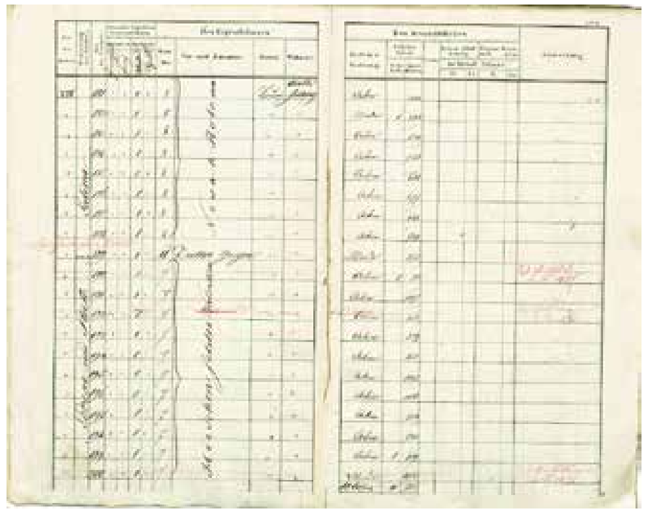
A surveyor has the knowledge and skills to measure and map the “Earth and sky” using a variety of geodetic instruments and equipment.

Real property can be acquired based on an authentic document that identifies the real estate’s location, shape, and size in addition to ownership.

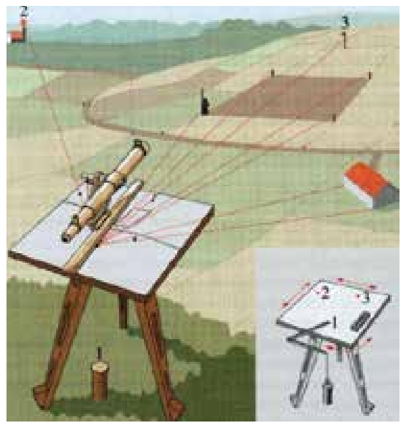
This is based on cartographic representations, and numerical data on the real estate produced two hundred years ago.

The survey’s objective was to establish, in conformity with the adopted regulations, a reliable land cadastre that would ensure fair taxation of agricultural production. The physical properties of the land were also determined. Integrating graphical and descriptive data and land properties into the land cadastre system provided solid grounds for taxation.

Franciscejski katastrski načrt.
Franciscan cadastral map.



Atributni podatki franciscejskega katastra.
Attribute data of the Franciscan cadastre.



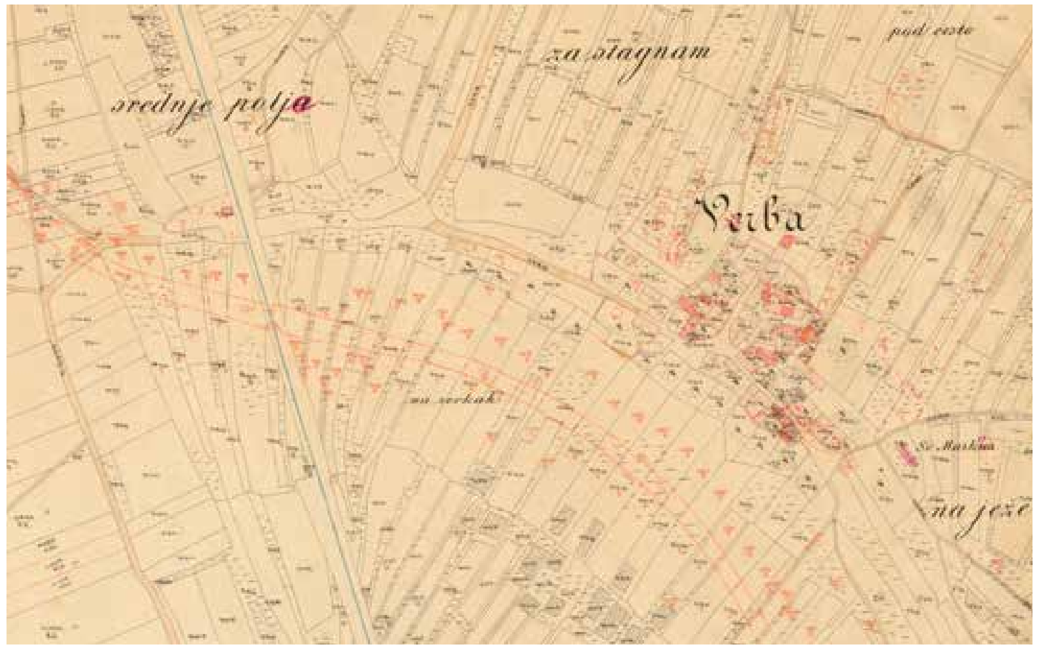
Merski pribor za izdelavo franciscejskega katastra.
Measuring accessories used in the production of the Franciscan cadastre.

Skozi desetletja so se podatki o nepremičninah spreminjali (parcelacije, odmere dolžinskih objektov, komasacije), največje spremembe pa je prinesel Zakon o zemljiški odvezi leta 1848.

Novi katastrski predpisi po letu 1896 so naložili sprotno evidentiranje sprememb. K temu je pripomogla povezava katastra in zemljiške knjige, kar je pomenilo skupen vnos podatkov o spremembi parcelnega stanja in lastništva. Tako kataster ni bil več samo davčni sistem. Zakon iz leta 1883 je predvidel, da se v vsaki provinci ustanovi civilna katastrska služba (izmeritveni oddelek), ki je imela svoj izmeritveni okoliš (zaradi povezave z zemljiško knjigo je pokrival enega ali več sodnijskih okolišev).

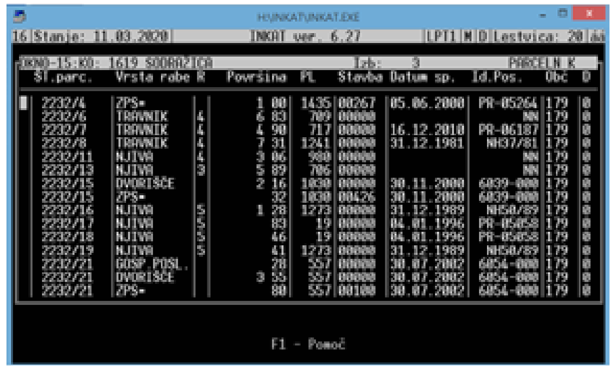
Over the decades, real estate data have changed (parcel/plot allocation, assessments of longitudinal structures, land consolidations), but the most significant changes were brought about by the agrarian reform of 1848.

The new, post-1896 cadastral regulations imposed real-time recording of changes facilitated by the connection between the cadastre and the land register, allowing concurrent entry of data on changed situations and ownership of the land plot. Consequently, the cadastre stopped being just a tax system. The 1883 Act imposed the establishment of a civil cadastral service (survey department) in each province, which had its survey district (due to its connection to the land register, it could cover one or several judicial districts).



Vris dolžinskega objekta.
Inscription of a longitudinal structure.

Kipregl je instrument, ki se je uporabljal v prvih desetletjih vzdrževanja katastrskega operata.
A telescopic alidade is an instrument used in the first decades to maintain the cadastral record.



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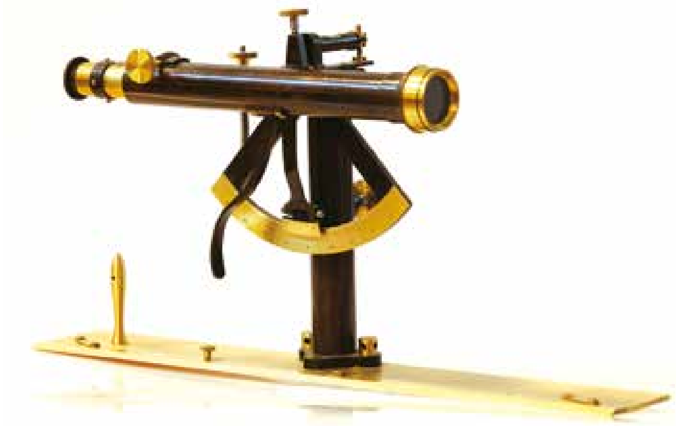
16 Stanje: 11.03.2020 INKAT ver. 6.27 LPT1 M D Lestvica: 20

OKNO-15:KO: 1619 SODRAŽICA Izb: 3 PARCELN K

Št.parc.	Vrsta rabe	R	Površina	PL	Stavba	Datum sp.	Id.Pos.	Obč	D
2232/4	ZPS*		1 00	1435	00267	05.06.2000	PR-05264	179	0
2232/6	TRAVNIK	4	6 83	709	00000		NN	179	0
2232/7	TRAVNIK	4	4 90	717	00000	16.12.2010	PR-06187	179	0
2232/8	TRAVNIK	4	7 31	1241	00000	31.12.1981	NH37/81	179	0
2232/11	NJIVA	4	3 06	980	00000		NN	179	0
2232/13	NJIVA	3	5 89	706	00000		NN	179	0
2232/15	DVORIŠČE		2 16	1030	00000	30.11.2000	6039-000	179	0
2232/15	ZPS*		32	1030	00426	30.11.2000	6039-000	179	0
2232/16	NJIVA	5	1 28	1273	00000	31.12.1989	NH50/89	179	0
2232/17	NJIVA	5	83	19	00000	04.01.1996	PR-05058	179	0
2232/18	NJIVA	5	46	19	00000	04.01.1996	PR-05058	179	0
2232/19	NJIVA	5	41	1273	00000	31.12.1989	NH50/89	179	0
2232/21	GOSP.POSL.		28	557	00000	30.07.2002	6054-000	179	0
2232/21	DVORIŠČE		3 55	557	00000	30.07.2002	6054-000	179	0
2232/21	ZPS*		80	557	00100	30.07.2002	6054-000	179	0

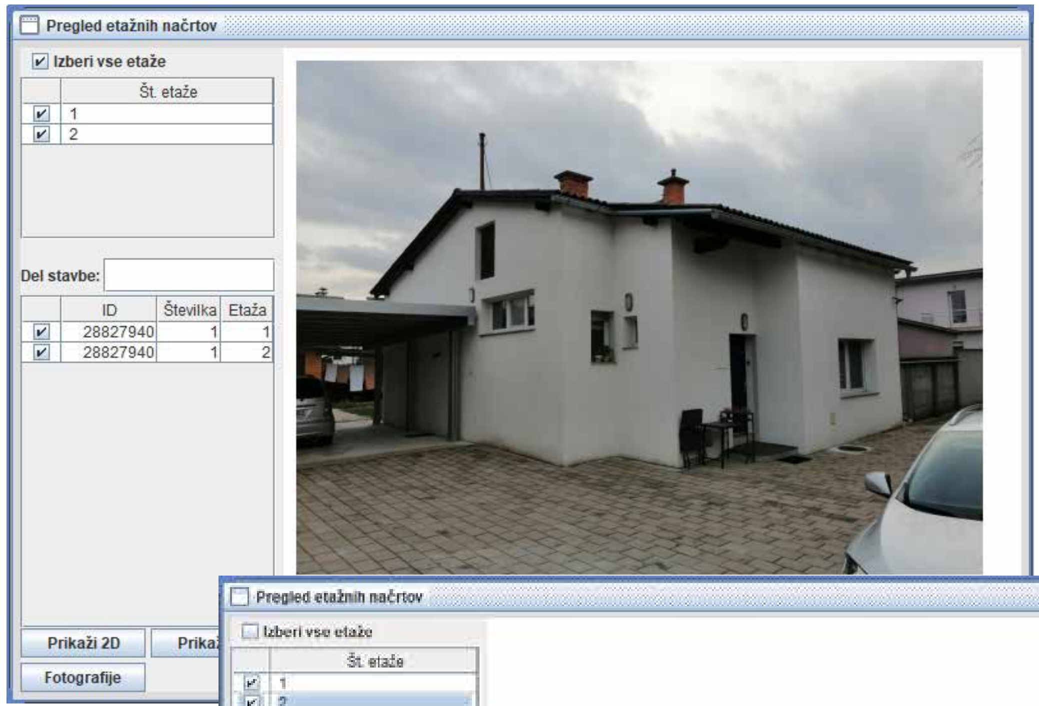
F1 - Pomoč

Vpogled v atributni del digitalnega zapisa katastrskih podatkov.
Attribute section of digitized cadastral data.

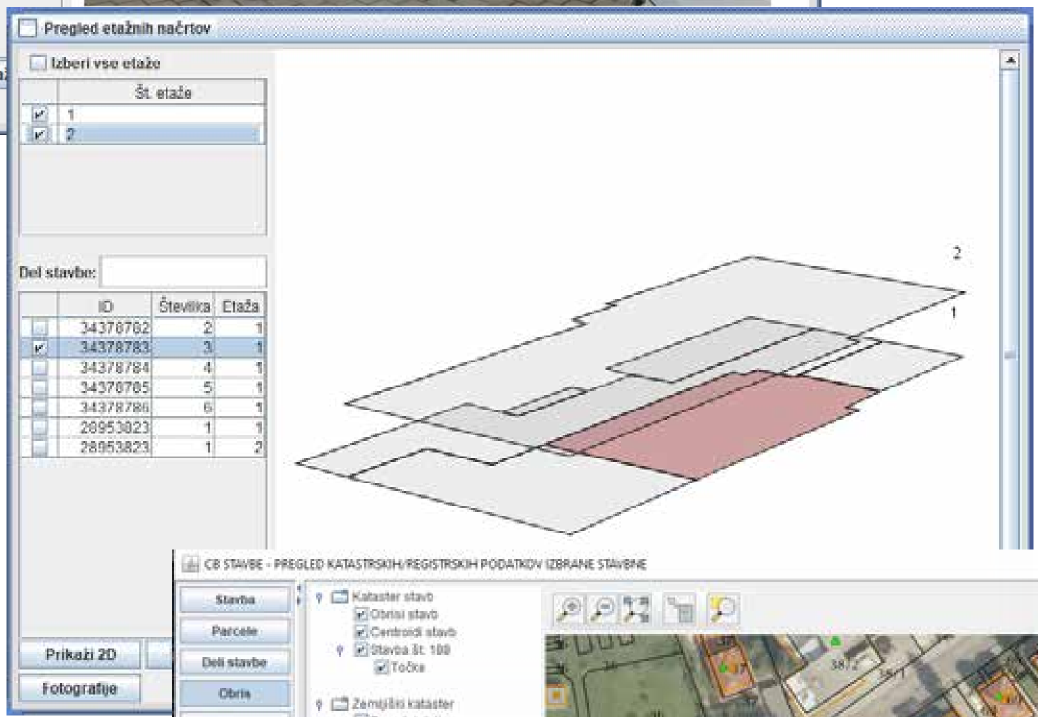


Po letu 2000 se v slovenski pravni red uvede kataster stavb, temeljna evidenca o stavbah in njihovih delih. V evidenci katastra stavb so vpisani podatkih o površini, obliki in legi, vrsti rabe in številki stanovanja ali poslovnega prostora. Podatki o lastniku (dokončnem lastniku) so prevzeti iz zemljiške knjige. Izvorni podatek, ki se vodi v katastru stavb, je tudi upravljavec stavbe ali dela stavbe, ki se vodi za stavbe ali dele stavbe v lasti države ali lokalne skupnosti.

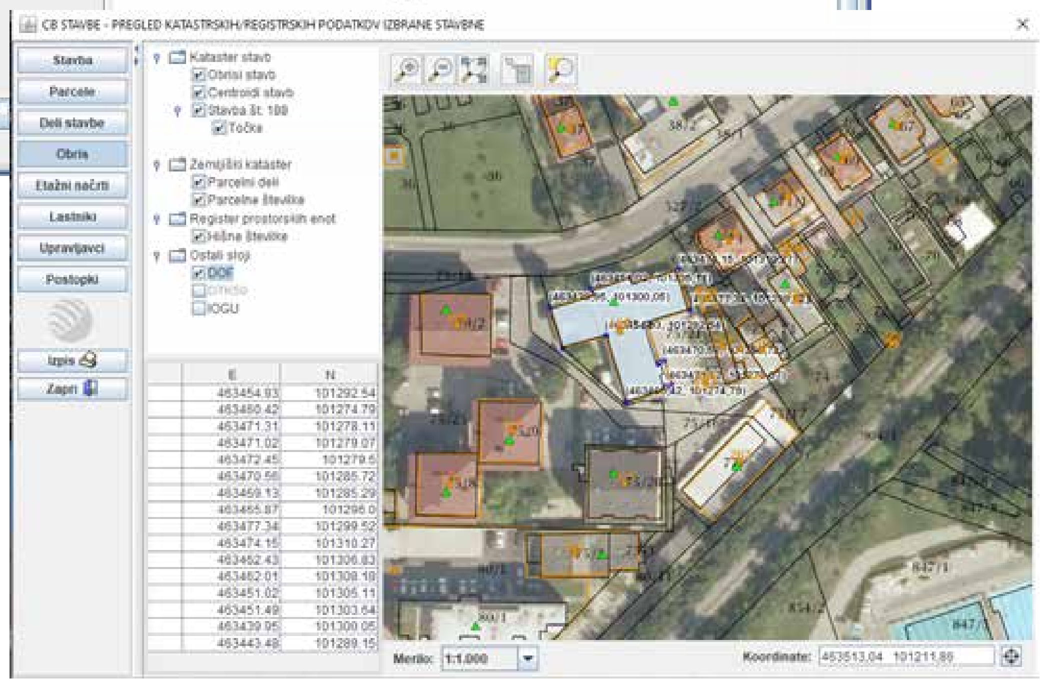
Introduced in Slovenia after 2000, the building cadastre is the central record of buildings and their parts. The records of the building cadastre contain data on the area, shape and location, type of use, and the number of the apartment or business premises. The information on the owner (the record owner) derives from the land register. A record kept in the building cadastre for buildings or parts of buildings owned by the state or local community is also the manager of the building or part of the building.



Fotografija objekta kot dokaz verodostojnosti podatkov, izkazanih v katastru stavb.
A photograph of the building as proof of the authenticity of the data recorded in the building cadastre.



3D vpogled v centralno bazo (CB) stavb.
3D access into the central database of the building cadastre.

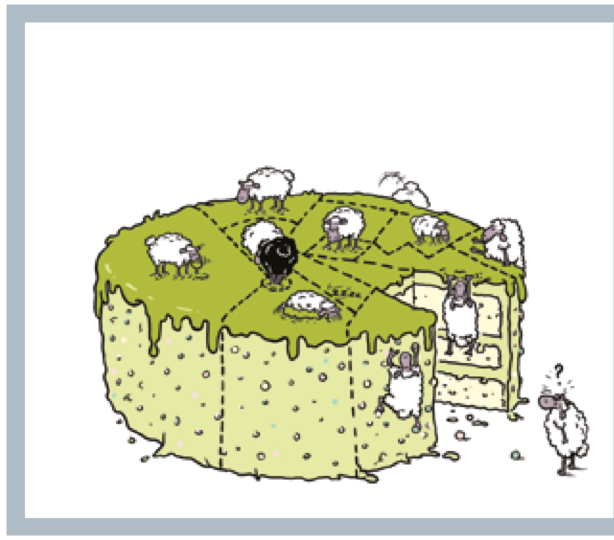


Vpogled v katastrske podatke za izbrano stavbo.
Access to the cadastral data for a selected building.

Če danes prek spleta vpogledujemo v podatke o nepremičninah in se nam to zdi popolnoma samoumevno, je lastnik še pred 30 leti podatke lahko pridobil le v tiskani obliki z obiskom katastrskega urada.

While today we can access real estate data online and take it for granted, 30 years ago, the owner could only obtain data in hard copy by visiting the cadastral office.

Mapna kopija iz leta 1888, opremljena s predpisano taksno vrednotnico.
Map copy from 1888, replete with stamp duty.



Parcelacija
Je katastrski postopek, ko razdelimo eno parcelo na več delov ali združimo več parcel v eno. Sestavljen je iz inženirskega (terenskega ter pisarniškega) in upravnega dela.

Parcel allocation
A cadastral procedure that divides one parcel of land into several parts or combines several parcels into one. It consists of an engineering (field and office) and an administrative part.

7.6 DIGITALNA PREOBRAZBA KATASTRA NEPREMIČNIN

IT OVERHAUL OF REAL ESTATE REGISTERS

V obdobju od leta 2016 do leta 2022 se je izvajal projekt Program projektov eProstor. Naložbo sta sofinancirali Republika Slovenija in Evropska unija iz Evropskega sklada za regionalni razvoj.

V sklopu programa je bil vzpostavljen nov informacijski sistem Kataster. Enotna informacijska rešitev omogoča sodobno delovanje sistema evidentiranja nepremičnin ter z uvedbo celovitega elektronskega poslovanja odpravlja številne administrativne ovire.

Between 2016 and 2022, the Mapping and Surveying Authority implemented the Programme of the eProstor projects, which was co-financed by the Republic of Slovenia and the European Union from the European Fund for Regional Development.

One of the projects within the Programme resulted in establishing a new information system of the Real Estate Register. A unified IT solution allows modernised processes of registering real estate and by facilitating e-commerce, removes many administrative barriers.

Spreminjanje podatkov v katastru nepremičnin.

Recording changes to the Real Estate Register.

Naročnik (zemljiškoknjižni lastnik, upravnik, upravljalec, pridobitelj) poda vlogo pri pooblaščenem izvajalcu.

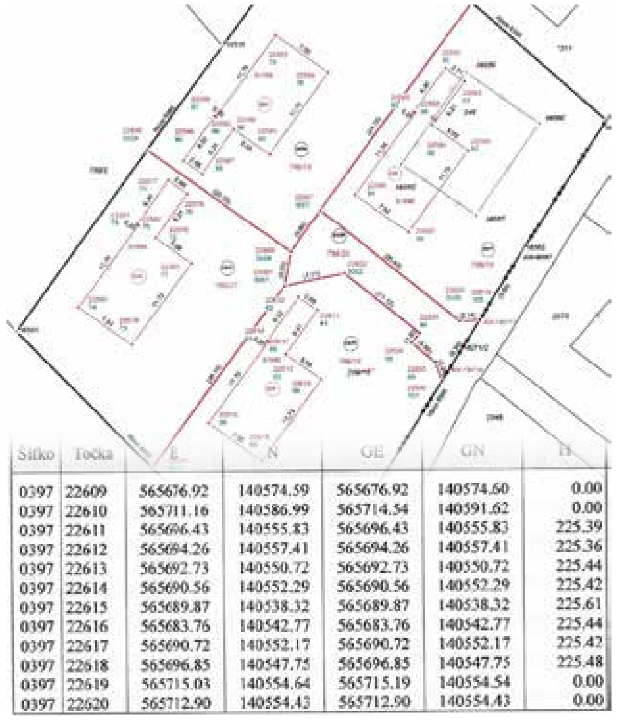
The client (land-register owner, manager, operator, acquirer) applies to a licensed contractor.

Pooblaščeni izvajalec (geodetsko podjetje, sodni izvedenec geodetske stroke, projektant) opravi objavo katastrskega postopka v Informacijskem sistemu (IS) Kataster, izdela elaborat izmere in v IS Kataster vloži zahtevo za vpis.

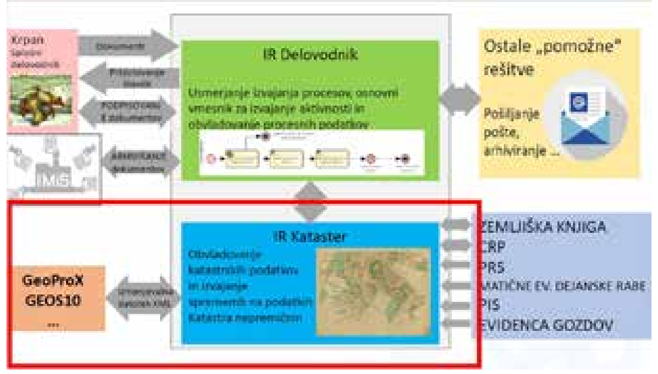
A licensed contractor (surveying company, expert in geodetic engineering, designer) submits the request for the cadastral procedure to the application IS Kataster, elaborates a survey report and submits the request for registration to the IS Kataster.

Informacijska rešitev (IR) Kataster – izvede topološke kontrole, informacijska rešitev (IR) Delovodnik – skrbi za postopkovni del, IS Krpan – nudi podporo upravnemu delu.

Information solution IR Kataster – provides topological data checks, Information solution IR Delovodnik – expert elaborate at different stages of the administrative part of the procedure, IS Krpan – information solution for office management.

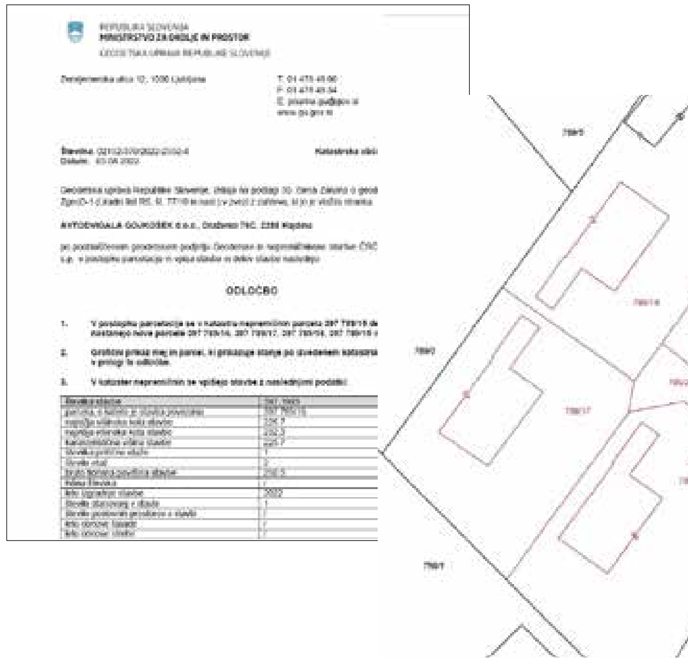


Šifko	Točka	E	N	GE	GN	H
0397	22609	565676.92	140574.59	565676.92	140574.60	0.00
0397	22610	565711.16	140586.99	565714.54	140591.62	0.00
0397	22611	565696.43	140555.83	565696.43	140555.83	225.39
0397	22612	565694.26	140557.41	565694.26	140557.41	225.36
0397	22613	565692.73	140550.72	565692.73	140550.72	225.44
0397	22614	565690.56	140552.29	565690.56	140552.29	225.42
0397	22615	565689.87	140538.32	565689.87	140538.32	225.61
0397	22616	565683.76	140542.77	565683.76	140542.77	225.44
0397	22617	565690.72	140552.17	565690.72	140552.17	225.42
0397	22618	565696.85	140547.75	565696.85	140547.75	225.48
0397	22619	565715.03	140554.64	565715.19	140554.54	0.00
0397	22620	565712.90	140554.43	565712.90	140554.43	0.00



GURS izvede upravni postopek odločanja o zahtevi (izdaja odločbe, po pravnomočnosti akta vnos sprememb v bazo katastra nepremičnin).

The Surveying and Mapping Authority conducts administrative procedures upon the clients' request (resolves the request, issues the certificate and makes changes to the real estate data records).



8 DRŽAVNA MEJA IN GEODEZIJA

STATE BORDER AND GEODESY

Geodetska dela pri vzpostavitvi Rapalske meje.
Survey works in the demarcation of the Rapallo border.

Meje? Nikoli jih nisem videl od blizu. Slišal pa sem, da obstajajo – v glavah nekaterih ljudi ...
Thor Heyerdahl

Borders? I have never seen one. But I have heard they exist in the minds of some people.
Thor Heyerdahl

Pa še kako obstajajo!

And yet they do exist!

Državne meje so v nedavni zgodovini precej usodno posegle v življenje Slovencev.

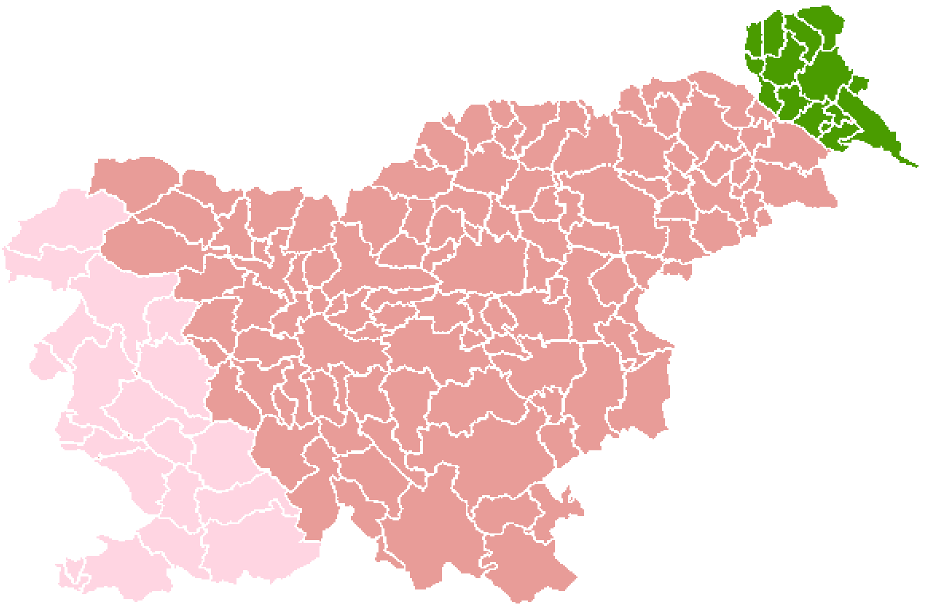
Rapalska pogodba je bila mirovna pogodba, ki sta jo 12. novembra 1920 v Rapallu podpisali Kraljevina SHS in Kraljevina Italija. Z njo je bila določena meja med državama, s katero so bili tretjina slovenskega etničnega ozemlja, Istra in del Dalmacije dodeljeni Italiji, ki je v zameno priznala Kraljevino SHS.

Slovenci, ki so živeli na Goriškem, delu Notranjske, v Trstu, Istri in na Primorskem so kmalu občutili raznarodovalni pritisk čedalje močnejšega fašizma. Začelo se je nasilno poitalijančevanje.

In recent history, national borders have had a fatal impact on the lives of the Slovenes.

The Treaty of Rapallo was a peace treaty signed on 12 November 1920 in Rapallo, Italy, between the Kingdom of Italy and the Kingdom of Serbs, Croats and Slovenes. It established the border between the two countries, allocating one-third of the Slovene ethnic territory, Istria and part of Dalmatia to Italy, which in return recognised the Kingdom of the SHS.

Slovenes living in Gorizia, parts of Notranjska, Trieste, Istria, and Primorska soon felt the denationalising pressure of increasingly powerful fascism.



Ozemlje današnje Republike Slovenije leta 1920: svetlo rožnata – Italija, rožnata – Kraljevina SHS, zelena – Prekmurje, dodeljeno Kraljevini SHS leta 1919.
Territory of the modern-day Republic of Slovenia in 1920: light pink – Italy, pink– Kingdom of the SHS, green – Prekmurje, assigned to the Kingdom of the SHS in 1919.

Koroški plebiscit iz leta 1920 je fenomen, katerega posledice še danes razdvajajo velik del slovenske in koroške javnosti. Razlaga, ki je verjetno najbližja resnici, je, da se je velik delež slovensko govorečega prebivalstva na plebiscitu odločil za Avstrijo.

The 1920 Carinthian plebiscite is a phenomenon whose consequences still divide many of the Slovene and Carinthian public. The modern interpretation, which is probably the closest to the truth, is that many of the Slovene-speaking population chose Austria in the plebiscite.

Slovenski kulturniki v Šentjakobu so po strehah hiš, ob polju in teniškem igrišču položili rdeč trak kot simbol meja, ki po sto letih še vedno obstajajo v glavah ljudi.

Slovene cultural activists in Šentjakob put red ribbons on the roofs of houses, the field, and the tennis court as a symbol of the borders that still exist in people's minds after a hundred years.

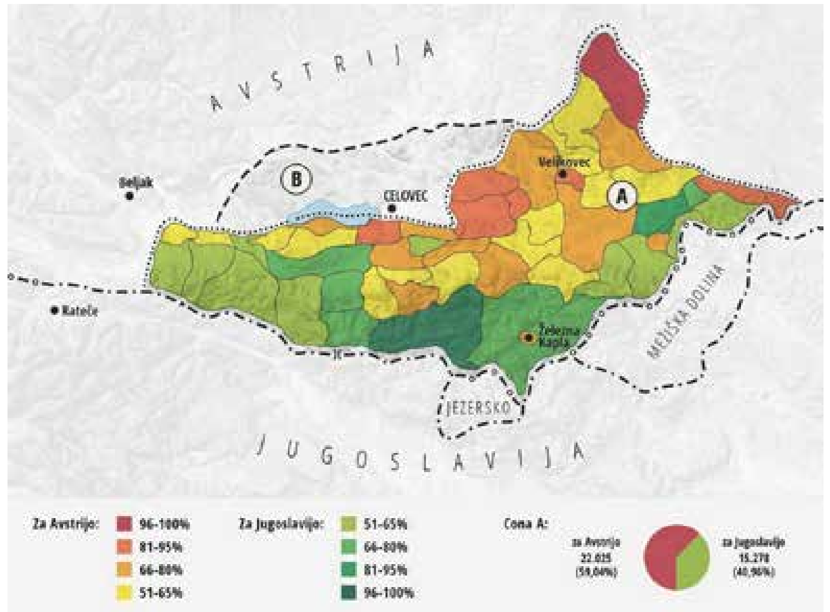
»Libeliče pripadajo Avstriji. Pod vasjo naj se v sedmih dneh postavijo mejniki, napelje bodeča žica in nastavi avstrijska straža. Prebivalci tega območja so nacionalno nezanesljivi, zato jim je treba v najkrajšem času vcepiti nemški duh in utrditi te labilne mejne kraje,« se je glasil avstrijski ukaz.

Za Avstrijo (vsaj mislili so tako) je bil problem urejen. Niti pomislili niso, da bi bila narodnostna zavest Libeličanov močnejša od avstrijskih zakonov in določil.

Že prvo noč po postavitvi državne meje so izruvali nekaj mejnih kamnov in tu in tam prerezali žico. Začel se je svojevrsten upor v zgodovini slovenskega naroda.

Nihče ni upošteval novih avstrijskih predpisov, ampak le tiste, ki so jih poznali pred 10. oktobrom 1920. Dve leti so premišljeno in skrbno vodili upor. Orožniki se zaradi ljubega miru niso upali približevati kmetijam, kjer so bila zborovanja, imeli pa so tudi dovolj dela s stalnim postavljanjem mejnikov, ki so jih dan za dnem izruvali libeliški fantje.

Po dveh letih kljubovanja Libeličanov so Avstrijci uporno vas vrniti matični domovini, v zameno pa so dobili neposeljeno ozemlje na levem bregu reke Drave.
Vir: *»LIBELIČE 1920–1922«*, 1982.



Shematski prikaz plebiscitarne volje leta 1920.
Schematic representation of the plebiscitary vote in 1920.

"Libeliče belongs to Austria. Within seven days, landmarks are to be set up, barbed wire installed, and an Austrian guard placed under the village. The inhabitants of this area are nationally unreliable, so the German spirit must be instilled in them as quickly as possible and consolidate these unstable border towns," read the Austrian order.

For Austria, the problem was solved – at least, that's what they thought. It never occurred to them that the national consciousness of the Libeliče villagers would defy the Austrian laws and regulations.

The very first night after the border was set up, some border stones were excavated, and the wire cut in several places. A rebellion unmatched in the history of the Slovene nation started.

No one complied with the new Austrian regulations, only those valid before 10 October 1920. For two years, the rebellion was led carefully and methodically. For the sake of peace, the militiamen did not dare approach the farms where the rallies were held, and they were also busy constantly re-setting landmarks dug up day in and out by the lads of Libeliče.

After two years of defiance, Austria returned the rebellious village to its homeland, receiving uninhabited territory on the left bank of the Drava River in exchange.
Source: *LIBELIČE 1920–1922*, 1982.

Kljub temu, da je 9. junija 2017 arbitražno sodišče v Haagu razglasilo končno razsodbo v arbitraži med Slovenijo in Hrvaško in s tem določilo morsko in kopensko mejo med državama, meja v naravi ni določena. Čeprav je arbitraža določila, da poteka povečini po mejah katastrskih občin, bi bilo ob demarkaciji anomalije, kot so vidne na sliki, smiselno urediti v obojestransko korist.

On 29 June 2017, the arbitral tribunal in the Hague delivered its final decision in the arbitration between Slovenia and Croatia, thus defining the maritime and land borders between the two countries, which, however, have not yet been defined in nature. The borders mostly follow the boundaries of the cadastral municipalities, it would make sense to settle the anomalies, as seen in the picture, to the benefit of both sides at the time of demarcation.

Hrvaška enklava sredi slovenskega ozemlja.
Croatian enclave within the Slovene territory.

Mejnik
Fizična označba parcelne meje v naravi. Mejnik smejo postaviti, prestaviti in odstraniti samo predstavniki geodetskega podjetja, sodni izvedenec geodetske stroke ali uslužbenci geodetske uprave.

Border mark
Physical marking of a parcel border in nature. Landmarks may be set up, moved, and removed only by personnel of the surveying company, a forensic expert in the surveying profession, or the Surveying and Mapping Authority staff.

9 GEODEZIJA IN VOJSKA

GEODESY AND MILITARY

- **Topografija – vojaške karte**
- **Izračuni za balistične namene**
- Topography – Military maps
- Numerical calculations of the ballistic trajectory

JURIJ BARTOLOMEJ VEGA (1754–1802) – matematik, fizik, geodet, meteorolog, plemič, topniški častnik

Vega je leta 1783 izdal znamenite logaritmične tablice. V uvodu je zapisal, da je bil njegov cilj napisati čimbolj natančne, vendar poceni tablice. Izračune je opravil s pomočjo vojakov, glavni namen pa je bil podati logaritme števil med 1 in 100.000. Za vsako najdeno napako v tablicah je Vega ponudil zlatnik.

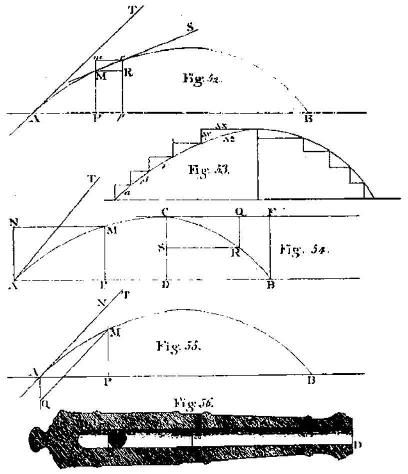
Leta 1788 je bila Avstrija prisiljena vstopiti v vojno in Jurij Vega je izrazil jasno željo, da se je udeleži. Želel je preveriti svoje matematično-vojaško znanje v vojni situaciji, zato mu je bilo dodeljeno poveljstvo nad topništvom.

Pod njegovim poveljstvom nad možnarskimi baterijami je leta 1792 padla trdnjava v Beogradu.

Leta 1781 se je Vega zavzemal za uvedbo metrskega sistema v Habsburški monarhiji. Njegova zamisel ni bila sprejeta, metrski sistem so uvedli šele leta 1871 za časa Franca Jožefa I.

Leta 1789 je Vega dosegel tedanji svetovni rekord v izračunu števila π na 137 decimalk. Rekord je obdržal 52 let do leta 1841. Izračun temelji na algoritmu oziroma spodnjih dveh enačbah:

$\pi=4\cdot(5\cdot\mathrm{arctg}(17)+2\cdot\mathrm{arctg}(379))$ in
$\pi=4\cdot(2\cdot\mathrm{arctg}(13)+\mathrm{arctg}(17))$



Matematični izračuni v Vegovih tabelah.
Mathematical calculations in Vega's logarithms tables.

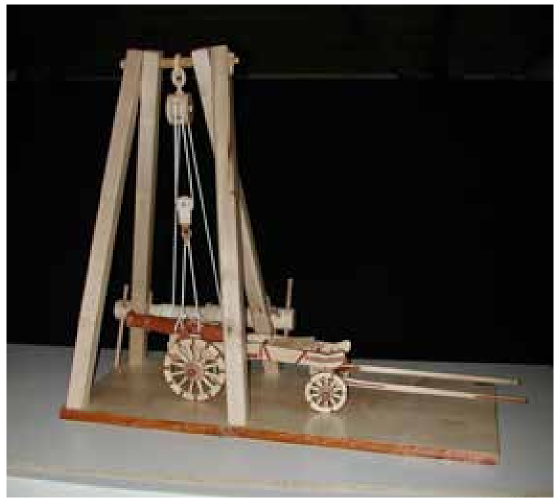
JURIJ BARTOLOMEJ VEGA (1754–1802) - Mathematician, Physicist, Surveyor, Meteorologist, Nobleman, Artillery Officer

In 1783, he published the first in a series of books on logarithm tables. In the introduction, he wrote that his objective was to write as accurate but inexpensive plates as possible. Common logarithms were calculated for the natural numbers 1 to 100,000, with soldiers under Vega's command performing the necessary calculations. Vega promised a gold coin for every notice of a mistake in the tables.

In 1788, Austria was forced to enter the war, and Jurij Vega wanted to take part to test his mathematical and military knowledge in a war situation. He was given command of mortar batteries.

His command of several mortar batteries contributed to the fall of the Belgrade fortress in 1792.

In 1781, Vega advocated introducing the new metric system in the Habsburg Monarchy. His proposition was rejected, and the metric system was only adopted almost a century later during the rule of Franz Joseph I.



Model artilerijskega dvigala, izdelan po Vegovi ilustraciji (hrani Tehniški muzej Slovenije).
Scale model of the artillery lift by Vega's illustration (kept at the Technical Museum of Slovenia).

In 1789 Vega achieved a world record in calculating π to 137 places. He kept it for 52 years until 1841. His calculation is based on the formulas below:

$\pi=4\bullet(5\bullet \mathrm{arctg}(17)+2\bullet \mathrm{arctg}(379))$ **and**
$\pi=4\bullet(2\bullet \mathrm{arctg}(13)+\mathrm{arctg}(17))$

Ta sestavljeni stroj je služil za premeščanje topovskih in možnarskih cevi z vozov na lafete ali obratno. Takšno dvigalo iz treh ali štirih v piramido postavljenih tramov, s škripčevjem pod vrhom in vitlom ob strani je lahko vključevalo tudi zobniški prenos in omogočalo, da je s tritonsko artilerijsko cevjo rokovalo le šest mož.

This compound machine served to transfer cannon and mortar barrels from cart transports onto gun carriages and vice versa. Such a lift made of three or four timber beams forming a pyramid and a pulley system suspended under the top could be further augmented by a cogwheel transmission device, making it possible for a mere six men to manipulate a three-tonne artillery piece.

FRANZ KUHN FREIHERR VON KUHNENFELD (1817–1896) – general, feldmaršal, minister, guverner avstrijskih dežel

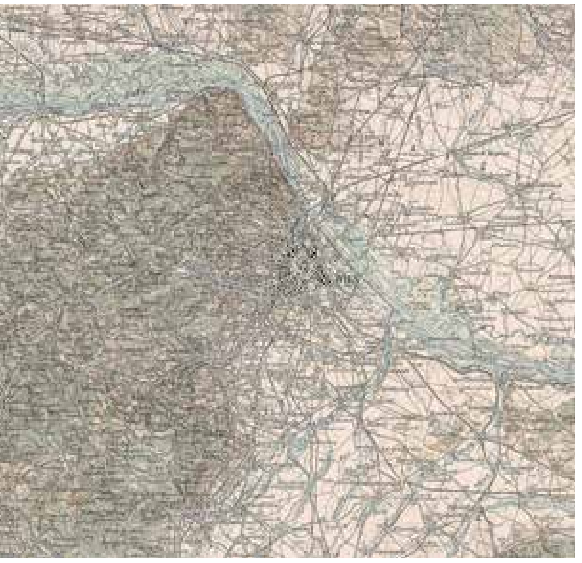
Leta 1860 je bil imenovan za poveljnika 17. pešpolka, v katerem so služili predvsem vojaki iz Kranjske dežele.

Baron Kuhn je veljal za široko razgledanega moža. Med drugim je spisal znamenito delo o vojskovanju po gorah, ki je bilo prevedeno v več evropskih jezikov.

Ker se v izgubljeni vojni proti Prusiji obstoječi vojaški zemljevidi niso izkazali za uspešne, je 8. oktobra 1869 vojni minister Kuhn cesarju predlagal ponovno merjenje celotne monarhije.

V 18 letih je Dunajski vojaški geografski inštitut izvedel F*ranzisco-Josephinishe Landesaufnahme*, znano tudi kot *Kuhn'sche Landesaufnahme*.

Sedanja Zemljemerska ulica v Ljubljani se je od leta 1896 do 1919 imenovala Kuhnova cesta.



Območje Dunaja – izsek karte v merilu 1 : 75.000.
Area of Vienna – section of the map in the scale of 1:75 000.

FRANZ KUHN FREIHERR VON KUHNENFELD (1817–1896), General, Field Marshal, Minister, Governor of the Austrian Lands

Commander of 17th infantry regiment composed mainly of Carniolan soldiers.

Baron Kuhn was considered a very knowledgeable man. Among many accomplishments, he was the author of a famous book dealing with alpine warfare which was translated into several European languages.

Since Austria-Hungary military charts had proven inadequate in the Austro-Prussian War, on 8 October 1869 Kuhn, the Minister of War, asked Emperor for permission to undertake a new cartographic survey of the whole monarchy.

Over the following 18 years, the Military Geographical Institute in Vienna undertook the new Franzisco-Josephinian Land Survey (also known as the Kuhn Land Survey).

Between 1896 and 1919, today's Zemljemerska Street in Ljubljana was named Kuhn Street.

MIROSLAV PETERCA (1926–2006) – generalmajor, geodet, načelnik Vojaško-geografskega inštituta JLA, profesor na Univerzi v Ljubljani

Miroslav Peterca je zaslužen, da je Slovenija že v času osamosvojitve razpolagala z odličnimi, dovolj podrobnimi topografskimi kartami, ki smo jih sicer za nekoliko drugačen, rekli smo mu civilni namen, pridobili s tedanjega Vojaškega geografskega inštituta.

Vojaški geografski inštitut je bil cenjen po strokovnosti in skoraj edini med podobnimi vojaškimi ustanovami na svetu, ki so konec 80. let imele popolno kartografsko podporo za svoje državne in obrambne potrebe. Šlo je za izvorne karte meril 1 : 25.000 in 1 : 50.000. Poleg topografije je veliko delal na toponimih in tudi v OZN zagovarjal načelo izvornosti toponimskega zapisa. Citat z njegovega nastopa na konferenci OZN: *»Pravica do uporabe zemljepisnih imen v svojem jeziku in pisavi je sestavni, neločljivi in neodtujljivi del splošnih pravic vsakega naroda in narodne manjšine.«*

MIROSLAV PETERCA (1926—2006), Major General, Surveyor, Chief of the Military Geography Institute of the JNA, Professor at the University of Ljubljana

Miroslav Peterca is credited with the fact that Slovenia, in the time of independence path, had excellent, sufficiently detailed topographic maps obtained from the Belgrade Military Geographical Institute for what was allegedly a civilian purpose.

Under his watch, the Military Geography Institute in Belgrade was comparable and one of the few similar military institutions in the world, which in the late 1980s had complete cartographic support for the country's national and defense needs. These were original maps at scales of 1:25 000 and 1:50 000. In addition to topography, he worked extensively on toponymical terminology and advocated using geographical names in national languages at the UN. A quote from his report submitted to the UN conference on the standardisation of geographical names in Montreal, 1987: *"The right to use geographical names in their own language and writing system is an integral, inseparable and inalienable part of overall rights of every nation and national minority."*

Vojaška karta v merilu 1 : 50.000.
Military map in the scale of 1:50 000.

10 GEODEZIJA V PRAKSI / GEODESY IN PRACTICE

10.1 MAREOGRAF – DOLOČITEV NADMORSKE VIŠINE 0 METRA

TIDE GAUGE – DETERMINING ZERO ELEVATION

Mareograf v Kopru.
Tide gauge station in Koper.

Ko govorimo o nadmorski višini, že iz imena lahko sklepamo, da je to višina ‚nad morjem'. Pojavi pa se vprašanje, kako določimo točko, ki ima višino 0 m?

Izhodišče za določitev nadmorskih višin na kopnem so mareografska opazovanja. Mareograf je naprava, s katero spremljamo spreminjanje nivoja morja. Srednji nivo morja predstavlja ekvipotencialno ploskev, ki poteka skozi izbrano izhodiščno točko in predstavlja referenčno ploskev za določitev višin s pomočjo geometričnega nivelmana.

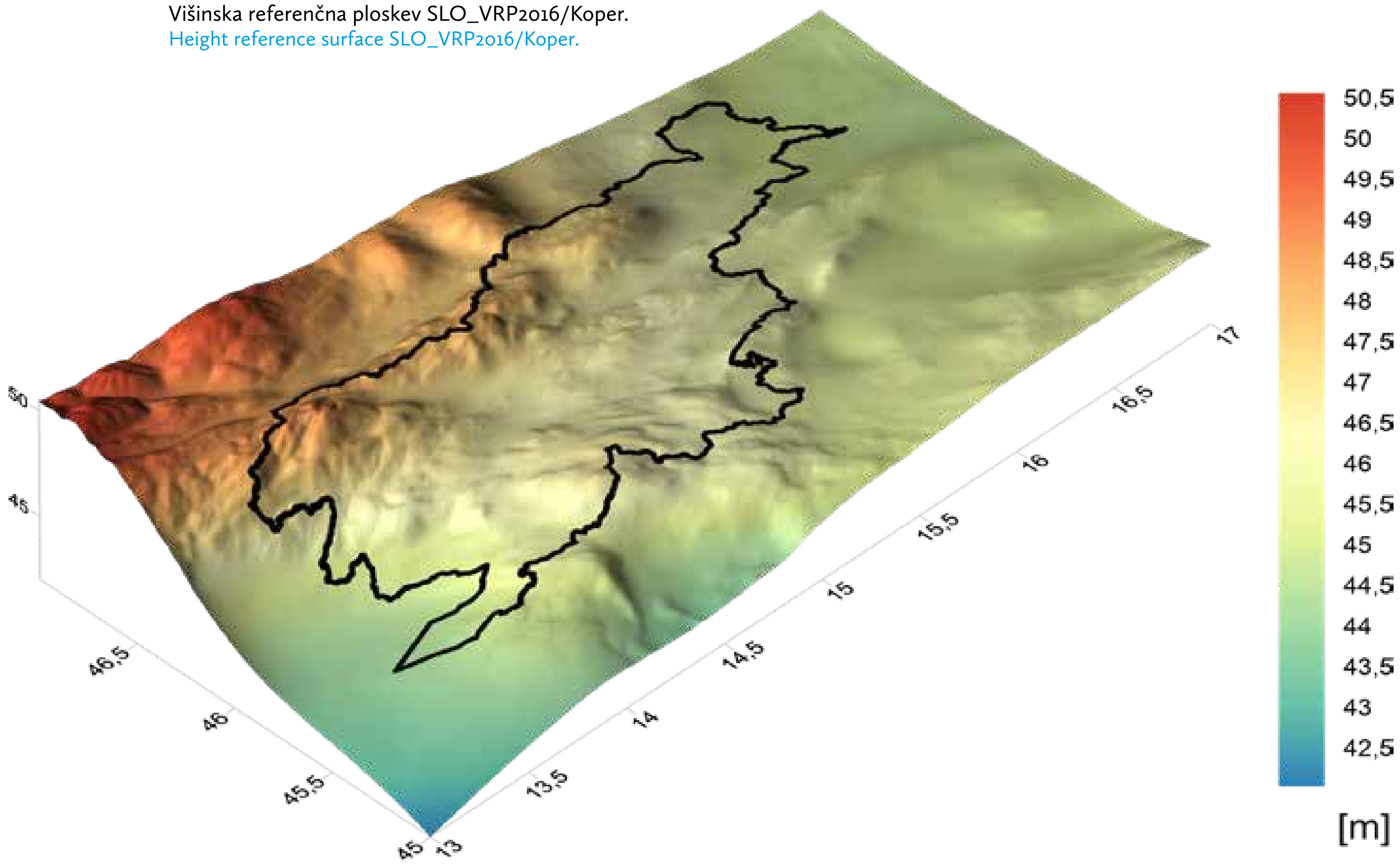
Srednji nivo morja izračunamo iz dolgoletnih opazovanj nihanj nivoja morja na mareografu. Za zanesljive podatke moramo nihanje nivoja morja opazovati neprekinjeno vsaj 18,6 let.

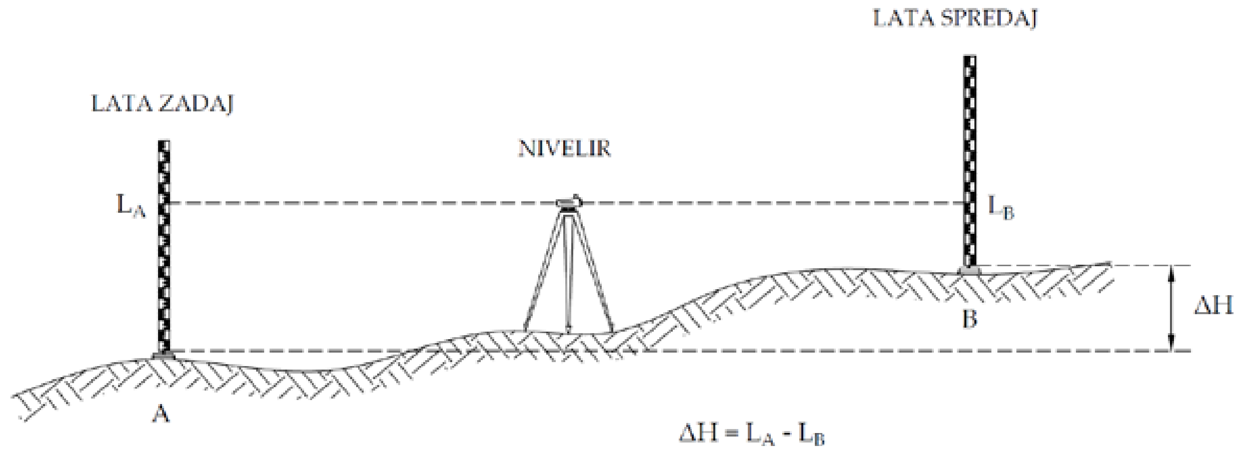
When talking about elevation, the name implies it is the height ‚above sea level.' The question that comes naturally is how we determine zero elevation.

A reference surface for measuring the height of objects on land is computed on sea level observations. A tide gauge is a device used for measuring the change in sea level. Mean sea level is an equipotential surface passing through a reference datum and is the reference surface for determining heights through geometric levelling.

The mean sea level is calculated from long-term observations of the changes in sea level on the tide gauge. To acquire reliable data, the observations have to be taken for at least 18.6 years.

Višinska referenčna ploskev SLO_VRP2016/Koper.
Height reference surface SLO_VRP2016/Koper.





Geometrični nivelman.
Geometric levelling.

Geometrični nivelman je najbolj natančna geodetska metoda višinomerstva. Višinsko razliko med dvema točkama določimo s pomočjo nivelirja. Nivelir je inštrument, ki zagotavlja horizontalno vizurno linijo in čitanje razdelbe na nivelmanskih latah, ki sta postavljeni na teh dveh točkah.

Geometric levelling is the most accurate field procedure for determining the heights of discrete points. The height difference is obtained from readings on levelling staffs where the level's horizontal sightline intersects them. The level is situated in the middle between two levelling staffs.

Višinske točke (reperji) se glede na stopnjo natančnosti povezujejo v različne nivelmanske mreže. V Sloveniji imamo stabiliziranih več kot 12.000 reperjev.

Benchmark – a permanent mark of height. The national height network is determined by over 12,000 benchmarks.

Reper.
Benchmark.

Reper

Stalna višinska točka z znano nadmorsko višino. Vzidana je v stabilno in nepremično podlago (stavbo, skalo). Višina je večinoma določena z milimetrsko natančnostjo.

Benchmark

A permanent mark of height with a determined elevation. It is embedded in a stable and immovable base (building, rock). The height is mainly determined with millimetre precision.

10.2 NAJNIŽJA IN NAJVIŠJA TOČKA V SLOVENIJI

LOWEST AND HIGHEST POINT OF SLOVENIA

Najnižja točka v Sloveniji je jama Kotredež v rudniku Zagorje in sega kar 261,10 m pod nivo gladine morja.

Najgloblja točka slovenskega morja je 38,4 m in se nahaja dobrih tristo metrov od Rta Madona v Piranu (koordinate: N 45° 31,974´, E 13° 33,700´). Označena je s posebno betonsko piramido, na kateri je vrisan na glavo obrnjen slovenski grb.

V povprečju je Jadransko morje globoko 240 m, košček slovenskega morja pa 17 m.

The lowest point of Slovenia is the Kotredež cave in the Zagorje mine, which is 261.10 m below sea level.

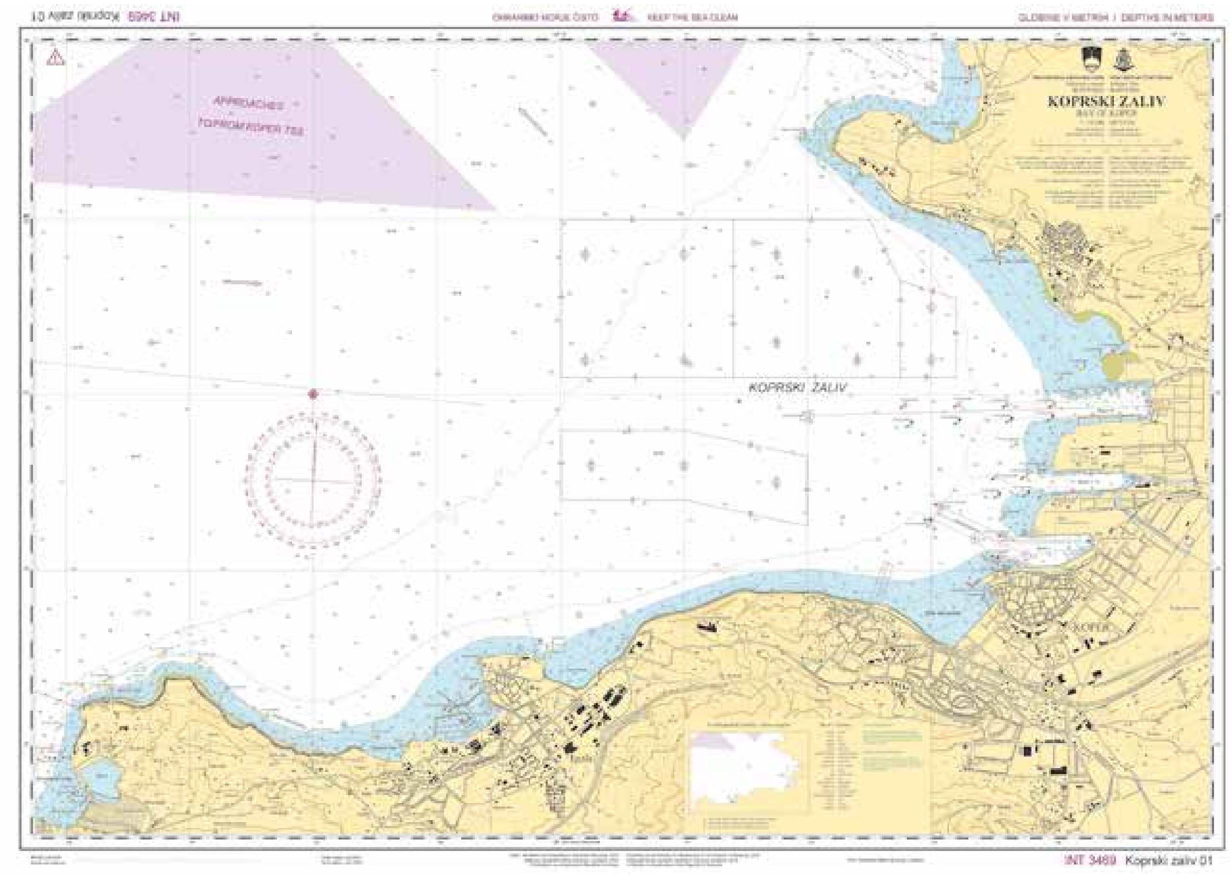
The deepest point of the Slovene sea is 38.4 m, located just over 300 m from Cape Madona in Piran (coordinates: N 45° 31.974´, E 13° 33.700´). It is marked with a concrete pyramid that has engraved an upside-down Slovene coat of arms.

The average depth of the Adriatic Sea is 240 m, with a tiny 17-metre-deep Slovene portion.

Karta Koprskega zaliva je prva slovenska pomorska karta. Nastala je s kombinacijo geodetskih in fotogrametrično izmerjenih topografskih podatkov za kopenski in hidrografskih ter navigacijskih podatkov za morski del.

The chart of the Gulf of Koper is the first Slovene nautical chart. It was created using geodetic and photogrammetric topographic data for the land and hydrographic and navigation data for the sea.

Prva slovenska pomorska karta, 3. izdaja 2019.
First Slovene nautical chart, 3rd edition 2019.



Hacquet, B. *Oryctographia Carniolica*, 1. del, 1778, Triglav.
Hacquet, B. *Oryctographia Carniolica*, vol. 1, 1778, Triglav.

Triglav je najvišji vrh Julijskih Alp in Slovenije ter tudi edini vrh, višji od 2.800 metrov v Julijcih in v Sloveniji. Gora je pomemben simbol slovenskega naroda.
Višina Triglava je bila prvič izmerjena leta 1779. Določil jo je zdravnik in botanik Baltazar Hacquet.

Za prvi geodetski podvig, povezan z našo najvišjo goro, velja vzpostavitev trigonometrične točke na vrhu Triglava v začetku julija 1822, in sicer v okviru triangulacije nekdanje Kranjske dežele za namene franciscejske katastrske izmere.

Najvišja točka v Sloveniji je Triglav (koordinate: 46° 22' 41,999" N, 13° 50' 12,001" E, 2864,65 mnm).

Triglav is the highest mountain in Slovenia, the highest peak of the Julian Alps, and the only peak higher than 2,800 metres in both the Julian Alps and Slovenia. The mountain is a prominent symbol of the Slovene nation. The height of Triglav was first measured in 1779. It was determined by the physician and botanist Baltasar Hacquet.

The first geodetic feat related to our highest peak was establishing a trigonometric point at the top of Triglav in early July 1822, as part of the triangulation of the former Carniola region for the purposes of the Franciscan cadastre.

The highest point in Slovenia is Triglav (coordinates: 46° 22‘ 41.999"N, 13° 50‘ 12.001"E, 2864.65 m).

V zgodovinskem zapisu o prvih raziskovalcih slovenskih gora in prvih dokumentiranih pristopih nanje najdemo pod zaporednima številkama trinajst in štirinajst naslednji navedbi o geodetski odpravi vzpona na vrh Triglava za potrebe triangulacije Kranjske v letu 1822:

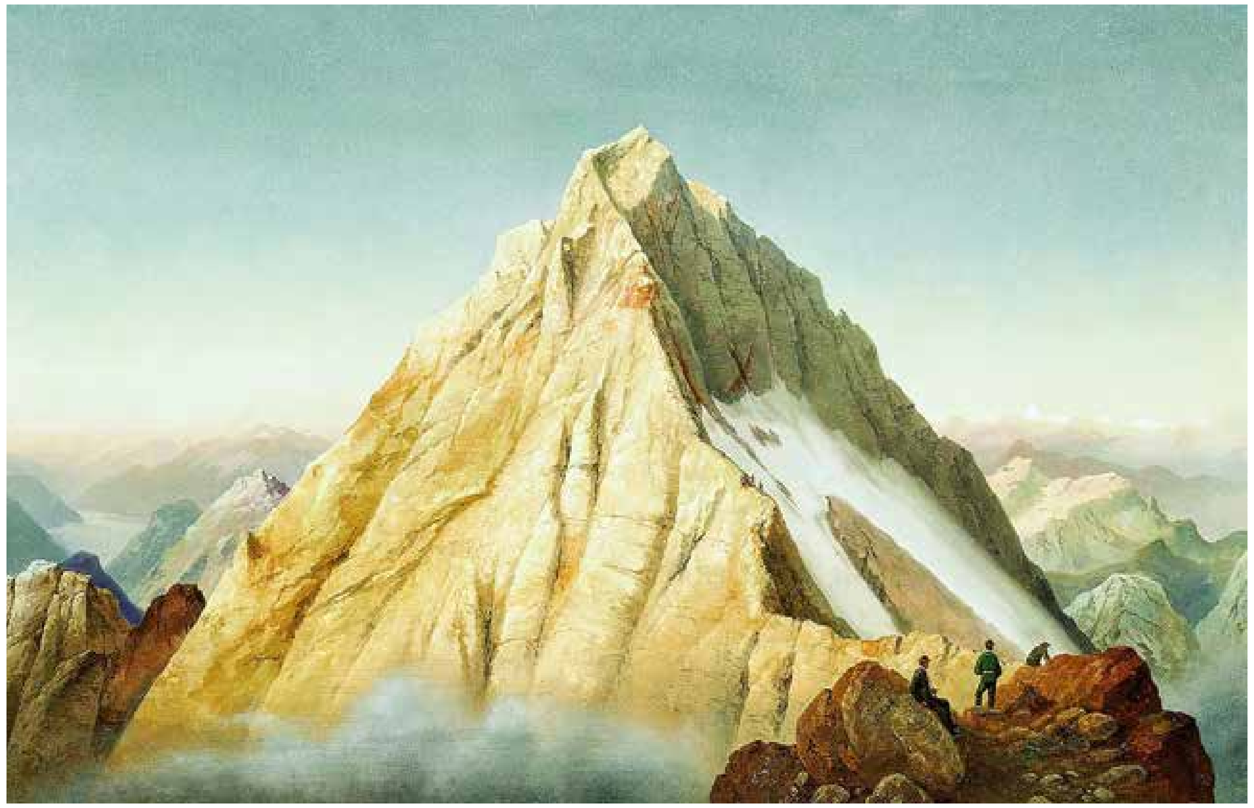
- Trinajsti pristop: 1822, zgodaj poleti prinesejo na vrh material za triangulacijsko piramido Anton Kos, Matija Korošec in Orjakov Šimen iz Podjelja z drugimi vodniki.
- Štirinajsti pristop: 1822, 5. julija se vzpnejo na vrh stotnik von Bosio, korporal Rothemmel, Anton Kos, Anton Korošec, Orjakov Šimen iz Podjelja in pet po imenu neznanih nosačev. Antona Korošca je ponoči na vrhu ubila strela.

5. julija 1822 se je stotnik Antonio von Bosio z vodniki in težkim zemljemerskim merilnim orodjem povzpel na vrh Triglava. Poverjena mu je bila naloga, naj sestavi trigonometrično omrežje Kranjske. Priprave in merjenje so bili zamudni. Bližala se je nevihta, vendar se je Bosio odločil, da bo prespal na vrhu, ker ni hotel pustiti merilnega aparata brez varstva. Ostali so odšli v dolino, z njim in korporalom Johannom Rothemmelom je ostal le 35-letni vodnik Anton Korošec. Med hudo nevihto je žal okrog 11. ure zvečer vodnika ubila strela. Naslednji dan so vodniki in nosači truplo Antona Korošca z velikimi težavami prinesli v dolino, kar je tudi prvo znano gorsko reševalno delo vodnikov in nosačev.

In the historical records about the first explorers of the Slovene mountains and their first documented exploits, we find under successive numbers 13 and 14 the following notes on a land surveying expedition to the Triglav's summit in the context of triangulation in Carniola in 1822:

- "13th ascent: 1822, early in the summer, Anton Kos, Matija Koršec, and Orjakov Šimen from Podjelje, together with other guides, deliver to the top the material for the triangulation pyramid.
- 14th ascent: 1822, 5 July, Captain von Bosio, corporal Rothemmel, Anton Kos, Anton Korošec, Orjakov Šimen from Podjelje, and five porters unknown by name ascend the mountain. At the summit, Anton Korošec is killed by lightning during the night."

On 5 July 1822, captain Antonio von Bosio, accompanied by guides carrying heavy land surveying and mapping equipment, climbed to the top of Triglav. A storm was approaching, but Bosio decided to spend the night at the summit because he did not want to leave the precious surveying apparatus unguarded. Others descended, and only the 35-year-old guide Anton Korošec remained with the captain and the corporal Johann Rothemmel. Unfortunately, the guide was killed by lightning at around 11 p.m. during a severe thunderstorm. The next day, the guides and porters, with much difficulty, carried the body of Anton Korošec off the mountain. This is the first known mountain rescue by guides and porters.



Pernhart, M. 19. stoletje, vrh Triglava.
Pernhart, M. 19th century, the top of Triglav.

Tradicijo geodetov preteklih rodov, ki so po vsem svetu na izpostavljenih vrhovih planin v smrtno nevarnih razmerah vzpostavljali triangulacijske mreže kot temelje geodetskih sistemov, moramo geodeti spoštovati, ceniti in ohranjati tudi v sodobnem času.

The tradition of land surveyors of past generations, who worldwide, on unprotected mountain tops in life-threatening conditions, established triangulation networks as the foundations of land surveying systems, must be respected, appreciated, and remembered by their contemporary colleagues.

Ilustracija iz koledarja *Gore in ljudje na starih razglednicah* iz 2018 prikazuje nevihto, ki je zajela geodetsko ekipo na vrhu Triglava.
An illustration from the calendar *"Mountains and People on Old Postcards"* shows a storm that engulfed a surveying team at the top o of Triglav (Koledar, 2018).

10.3 GEODEZIJA IN GRADNJA STANOVANJSKIH OBJEKTOV

GEODESY AND RESIDENTIAL CONSTRUCTION

Pri gradnji stanovanjskih objektov ima geodezija pomembno vlogo predvsem pri izdelavi dokumentacije in umestitvi v prostor. Za izdelavo projektne dokumentacije in pridobitev gradbenega dovoljenja je potreben geodetski načrt, iz katerega arhitekt, ki načrtuje objekt, razbere relief terena ter potek komunalnih vodov in parcelnih mej.

Sklepna faza gradbenega dovoljenja je zazidalna situacija, ki določa lego stavbe v prostoru, odmike od sosednjih objektov in parcelnih mej.

In residential construction, surveying is essential, especially regarding project documentation and spatial allocation. A prerequisite for well-designed documentation and acquisition of a building permit is a land surveying plan which provides the architect with information on the actual state of the terrain, the location of the public facilities and utilities, and the parcel boundaries.

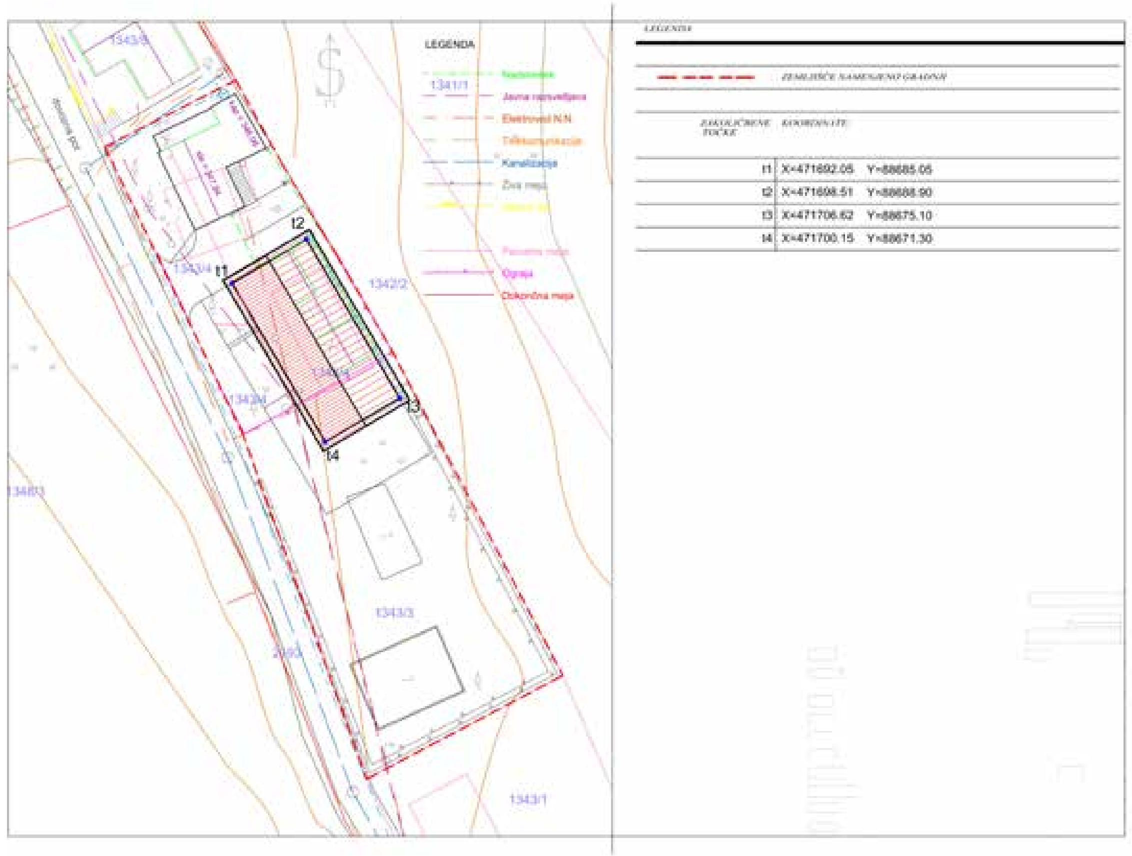
The final stage of the building permit is the site plan, determining the location of the building, distance from the adjacent buildings and distance from property lines.

Geodeti z zakoličenjem vogalov stanovanjske hiše na teren prenesemo načrtovani objekt. Vogale objekta najpogosteje zakoličimo s polarno metodo z uporabo elektronskega tahimetra in reflektorske prizme.

Točke, ki predstavljajo vogale objekta, najprej označimo z lesenimi količki in žeblji. Položaj zakoličenih točk pogosto zavarujemo z označitvijo presečnih linij na lesene gradbene profile. To so horizontalni leseni elementi, ki stojijo na podaljških linij objekta.

Izgradnji stanovanjske hiše navadno sledi dopolnitev geodetskega načrta z izmero novega stanja na terenu, ki vsebuje novozgrajeno stanovanjsko stavbo, zunanjo ureditev in nov potek komunalnih vodov.

Vodilna mapa z zakoličbenimi elementi.
Guide folder with stakeout elements.



Natančna označitev vogalne točke objekta na lesenem količku.

The corner of the building marked with nail in a wood stake.

By staking out the corners of a residential building, the surveyors map the layout of the planned structure out on the site. The method usually employed is polar, using an electronic tacheometer and a reflecting prism.

The corner posts of the building are initially marked with wood stakes, whereon nails are used to precisely mark the grade. Staked posts are usually secured by marking the cross-section lines on the outer face of the batter boards. Batter boards are horizontal boards set on the prolongations of the outside building lines.

Once the construction of the residential building is complete, the land surveying plan of the new situation of the land is produced, which includes the newly constructed building, its exterior design and the new alignment of the utility lines.

Izvedeni gradnji sledi evidentiranje nove stanovanjske stavbe v kataster stavb.

Geodetska uprava v katastru stavb vodi naslednje podatke (ZEN, 73. člen):

- identifikacija oz. številka stavbe ali dela stavbe,
- lastnik in upravljalec,
- lega in oblika,
- površina delov stavb,
- številka stanovanja ali poslovnega prostora.

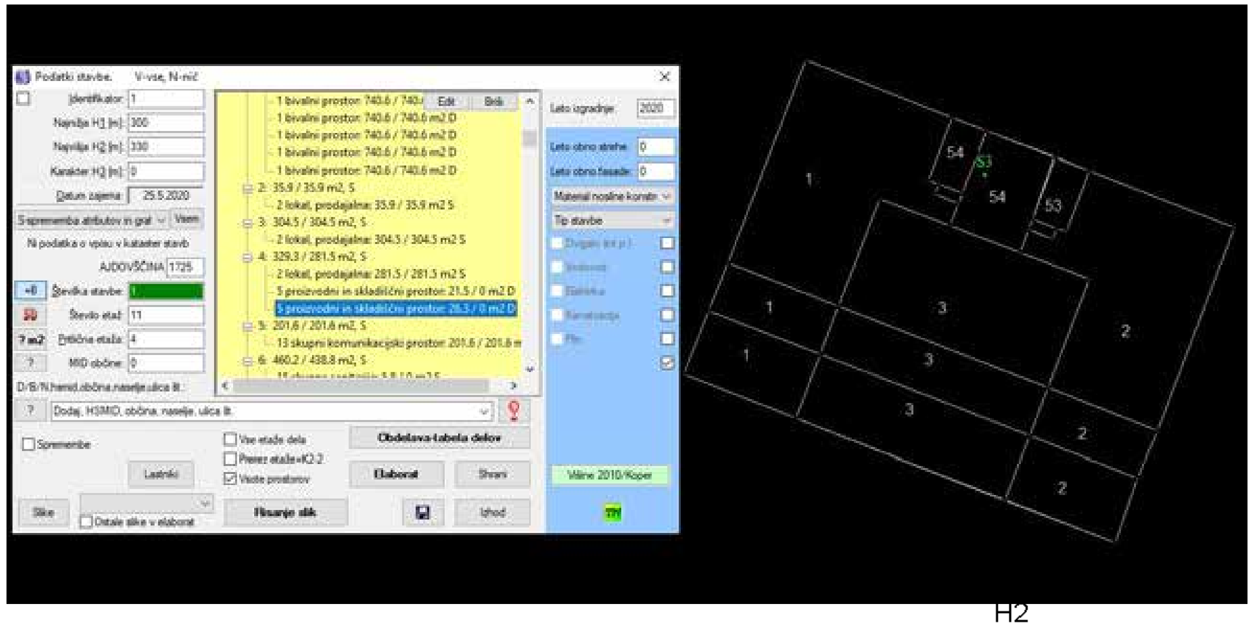
Investitor dobi hišno številko za stanovanjsko hišo potem, ko ima slednja uporabno dovoljenje in je vpisana v evidenco katastra stavb, ki ga vodi Geodetska uprava.

The new residential building is registered in the building cadastre when the construction is completed.

Compliant with the provisions of Article 73 of the Real Estate Records Act (Zakon o evidentiranju nepremičnin), the data recorded in the building cadastre also include the following:

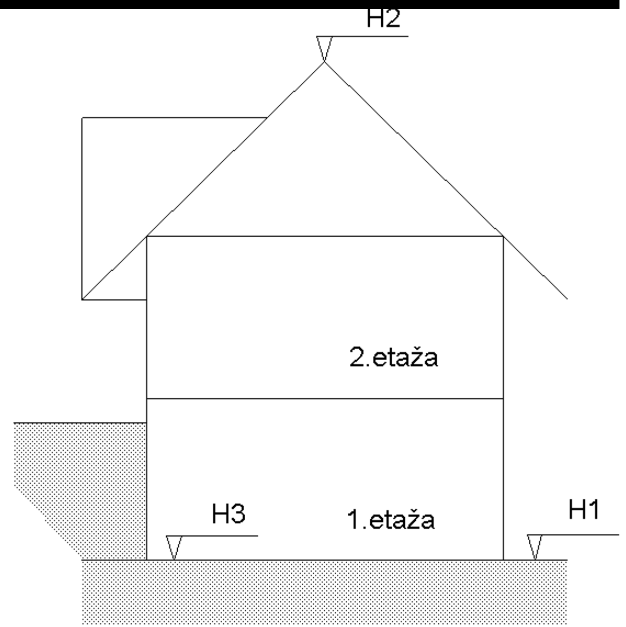
- the identification mark of a building or part of a building,
- owner and manager,
- position and shape,
- area of parts of the buildings,
- apartment or business premise number.

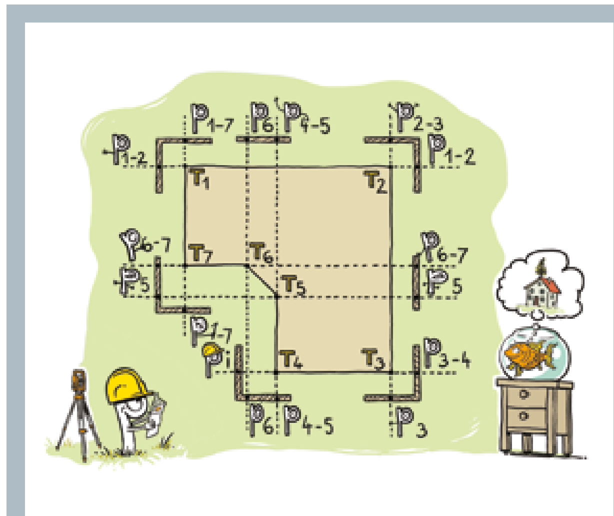
The investor obtains a house number for the residential building when the latter has an occupancy permit and registration in the building cadastre kept at the Surveying and Mapping Authority.



Izdelava elaborata za vpis podatkov o stavbi in delih stavb v evidenco katastra stavb.

Production of the report for entering data on buildings and parts of buildings into the building cadastre records.





Zakoličba

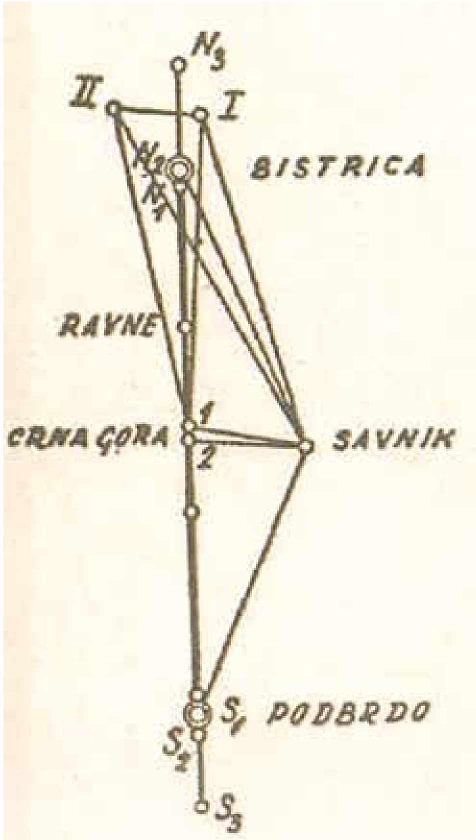
Zakoličenje objekta je prenos tlorisa zunanjega oboda načrtovanega objekta na teren oziroma prenos osi trase linijskih gradbenih inženirskih objektov na teren na način, ki zagotavlja izvajanje skladno z gradbenim dovoljenjem in dokumentacijo za izvedbo gradnje.

Construction staking

Staking is the process of calculating appropriate offset survey points and placing stakes in the field that mark the location and elevation of proposed construction in a way to ensure compliance with the building permit and pertinent documentation.

10.4 GEODEZIJA IN INŽENIRSTVO – BOHINJSKI PREDOR

GEODESY AND ENGINEERING – THE BOHINJ TUNNEL



Bohinjski predor je najzahtevnejši gradbeni objekt na slikoviti bohinjski železnici, eni najslikovitejših gorskih prog na svetu. Njegova gradnja je predstavljala izredno zahtevno nalogo tudi za geodete. Težko si v današnjem času ob razpolaganju s sodobno merilno tehniko predstavljamo, kako je bilo sploh mogoče v tako zahtevnem okolju z mehanskimi instrumenti zakoličiti več kot 6 km dolg predor, še danes najdaljši v Sloveniji.

Način izmere in zakoličbe je bil takrat, pred 120 leti, v principu enak, kot je danes. Treba je bilo razviti lokalno trigonometrično mrežo, ki je povezala območja obeh portalov. Mreža portala poveže preko tudi do 1700 m visokih vrhov Spodnjih Bohinjskih gora. Točke mreže so bile označene s posebnim kamnom z bakreno ploščico na vrhu, signalizirale pa so jih lesene piramide. Stalni točki sta bili tudi na vsakem vhodu v predor.

The Bohinj Tunnel is the most complex construction project on the Bohinj Railway, one of the world's most beautiful stretches of mountain train lines. Its construction was also a challenge on the part of surveyors. Indeed, it is difficult to imagine today, with modern surveying technology, how it was possible to mark the tunnel, with its six kilometres still the longest in Slovenia, in such a demanding environment using mechanical instruments.

Although 120 years ago, land surveying and marking methods were essentially the same as today. The surveyors set up a local trigonometric network that linked the two portal areas. The portal network connects the peaks of the Lower Bohinj Ridge, which rise to 1700 m high. The points were marked by a stone with a copper plate on top and signalled by wooden pyramids. Permanent points were set at both tunnel portals.

Mreža je triangulacijska, določena klasično, tako kot je to predlagal Snellius pred stoletji. V mreži so merili horizontalne kote. Delo je bilo zelo zahtevno, saj so točke med sabo zelo oddaljene. Da so jih lahko opazovali, so na točke postavili posebne lesene piramide – stalne signale. Mrežo so računali z izravnavo po delih, računalnikov ni bilo, računali so ročno, takrat so že uporabljali logaritmična računala, mogoče računske mlinčke in pamet. Natančnost izmere mreže so povečali in nadzirali z večkratno ponovitvijo meritev.

The network is triangulated, determined classically, as proposed by Snellius centuries ago, by measuring horizontal angles. It was an arduous undertaking due to the large distances between the points. To be able to observe them, sufficiently tall wooden pyramids were set up to signal their location. The network was calculated using a sequential method of adjustment. They made calculations using slide rules, possibly some mechanical calculator, and their brain. To increase and control the accuracy, the surveyors performed repeated measurements.

Os predora, ki jo je bilo treba zakoličiti, poteka skoraj v celoti v ravni črti. Os so pred začetkom izkopa na površini označili z lesenimi koli, zabitimi na vsakih 100 m. Težko si je predstavljati, kako zahtevno delo je to bilo.

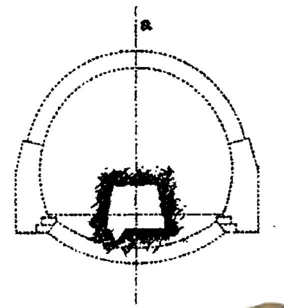
The tunnel's axis, which runs almost entirely in a straight line, was marked on the surface with wooden stakes driven 100 m apart. It is almost impossible to imagine what a complex and laborious this was.

Inženir Maks Klodič zapiše:

»Koliko težav ima inženir pri takem merjenju pod milim nebom! V gozdu je treba sekati les, da se vidi smer z daljnogledom; mnogokrat mora biti kol na takem kraju, da instrument komaj stoji na njem; in kadar ti enkrat varno stoji, se pa težavno kretaš okrog njega, da se ti vse skupaj ne prevrne in pade v kako brezno! Zraven pa še ti pazi in ukazuj pomočnikom, piši v knjižico in misli na vse drugo! Če nazadnje še dežuje, da se moraš skrivati pod dežnik, ki je razprt nad instrumentom, pa imaš težav dovolj, in slednjič si še moker kakor miš v vodi.«

Engineer Maks Klodič writes:

"All the trouble the engineer has doing the measurements under blue skies! Trees need to be cut in the forest to see the direction with binoculars; many times, the stake has to be in such a place that the instrument can hardly keep balance; and once it is safely placed, you have to move around very carefully so that it doesn't fall over ending up in some abyss! Besides, you must always be alert, give instructions to the assistants, write in your notebook, and constantly keep an eye on everything! On top of that, you might get caught by heavy rain and have to hide under an umbrella spread over the instrument – that's more than enough trouble to handle. Let alone you look like a drowned rat."



Predora niso kopali v celotnem profilu izkopa, ampak so najprej izkopali talni smerni rov. Zakoličba talnega smernega rova je bila razdeljena na približno in natančno, približno so opravili skoraj dnevno, natančno pa mesečno pod nadzorom posebne državne komisije za predore, sestavljene iz članov cesarske znanstvene akademije.

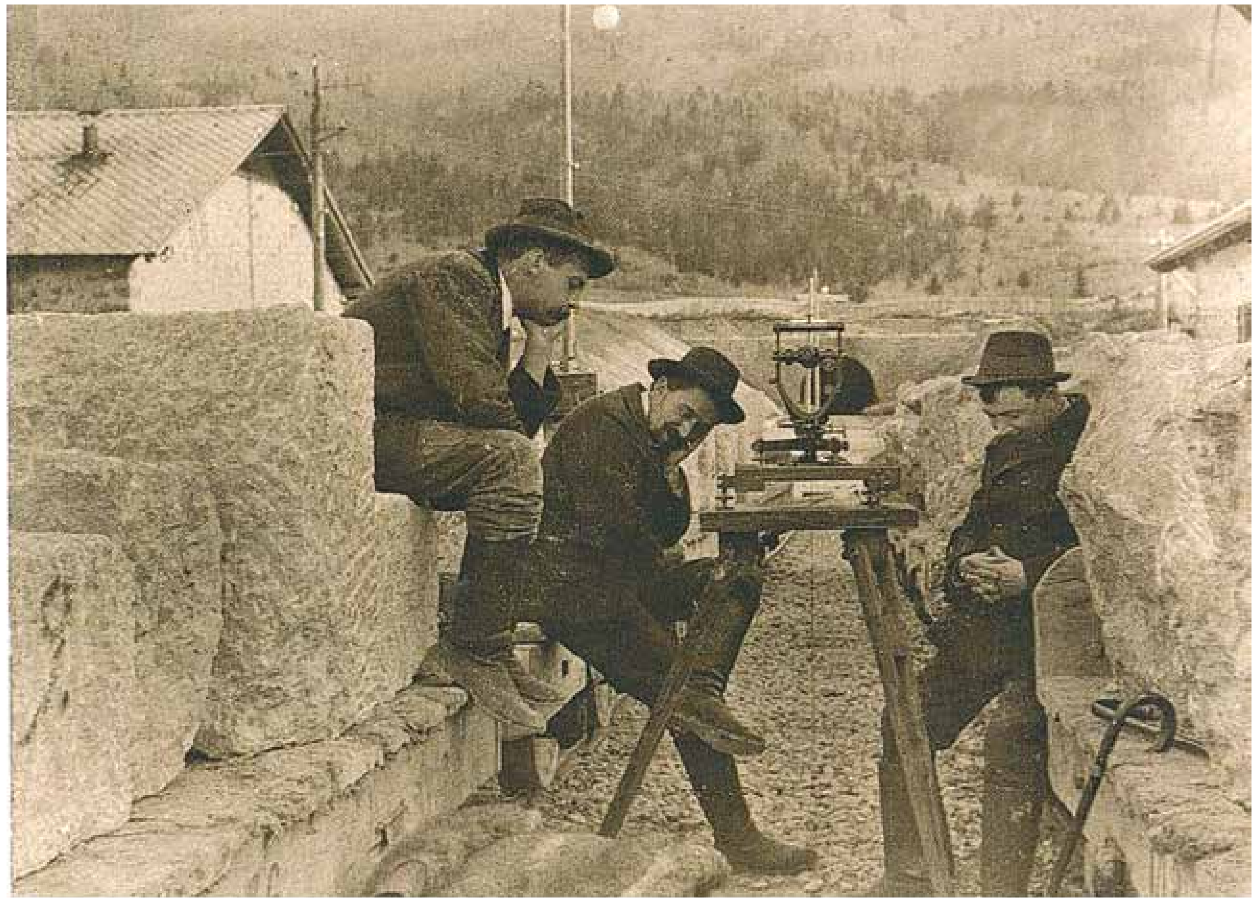
Instead of using the full-face tunneling method, the construction began with the excavation of the heading. The surveyors performed both accurate and rough staking. Rough staking was done every day, while accurate was carried out monthly under the supervision of the state tunneling commission composed of members of the Imperial Academy of Sciences.

Pri meritvah so uporabljali času primerne instrumente. Za zakoličbo horizontalne smeri so uporabili natančen teodolit brez vertikalnega kroga (transit, pasažni instrument).

The measurements were made using instruments of the time. They used precise theodolite with horizontal circle only (transit instrument) for 2D staking out, and level for 1D staking out.

Primer instrumenta iz tistega časa.

An instrument of the time.



Pri delu v predoru se je inženir (geodet) s pomočnikom (figurantom) pogovarjal po telefonu, da so se sploh slišali. Figurant je točko, ki jo je inženir zakoličeval, signaliziral s petrolejsko svetilko na trinožnem stojalu. Petrolejka je svetila skozi ozko režo valja, ki je zastiral svetilko. To režo je inženir z instrumentom viziral in ko je bila reža na projektirani smeri, je figurant s svinčnico prenesel smer na tla, kjer so jo označili.

While working in the tunnel, the communication between the engineer (surveyor) and his attendant was facilitated by phone. The attendant signalled the point that the engineer was staking out with a kerosene lamp mounted on a tripod stand. The lamp emitted light through a narrow slit in a cylinder that obscured the light source. Using the instrument, the engineer pointed the slit, and when the slit aligned with the design direction, the attendant plumbed it to the ground, at which point it was marked.

Za višinsko zakoličbo so uporabili nivelir z libelo. Delo z njim na tako zahtevnem gradbišču je bilo zelo oteženo, saj je bila zahtevana natančnost niveliranja od 2 do 3 mm na kilometer oddaljenosti med točkami.

The surveyors used an optical level (dumpy level) to stake out the height of points. Working with the instrument on such a demanding construction site was quite a challenge as the required levelling accuracy was 2 to 3 mm per kilometre of point-to-point distance.

Primer nivelirja iz tistega časa.
A level of the time.

Uporabljali so 5-metrske lesene late s cm razdelbo, ki so jo osvetlili s premično svetilko. Zakoličene točke so označili z vzidanimi kamni, vrhnja ploskev kamna, na kateri je bila označena projektirana smer, je predstavljala projektirano višino.

They used 5-metre wooden rods featuring a centimetre graduation, which they illuminated with a portable lantern. Staked-out points were marked with embedded stones. The top surface of a stone, with a symbol pointing to the design direction, indicated the design height.

Točnost preboja je bila glede na zelo zahtevne terenske pogoje in kompleksnost objekta neverjetna. Rezultati kontrole smeri, višin in stacionaže so bili osupljivo natančni. Odstopanja pri preboju so znašala:

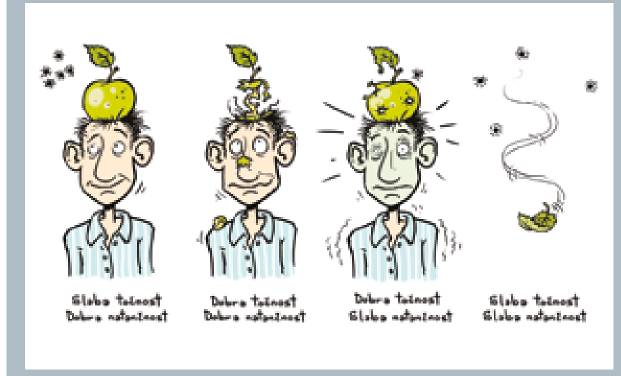
- 50 mm v horizontalni smeri
- 54 mm v vertikalni smeri
- 1.030 mm v dolžini.

Bohinjski predor je bil izvrtan najbolj točno od vseh dotedanjih tovrstnih gradenj. Uspeh geodetov je bil izjemen. Take točnosti so tudi za današnji čas ob uporabi sodobne merske tehnologije zavidanja vredne.

The accuracy of the breakthrough was astonishing, given the very challenging terrain and complex structure. The deviations in the breakthrough were:

- 50 mm horizontally,
- 54 mm vertically,
- 1030 mm length-wise.

Compared to previously built similar structures, the Bohinj Tunnel was drilled with incredible accuracy. The success of the surveyors was remarkable. Such accuracy is desirable even today with the use of modern surveying technology.



Točnost je stopnja ustreznosti merjene ali izračunane količine glede na njeno dejansko (resnično) vrednost. Točnost predstavlja verodostojnost merjene ali izračunane količine. V primeru geoprostorskih podatkov je točnost merilo, koliko se podatki na načrtu (npr. geografski položaj) ujemajo z vrednostmi v resničnem svetu.

Natančnost je stopnja, za katero nadaljnje meritve ali izračuni kažejo enake ali podobne rezultate. Natančnost pove, s kakšno ponovljivostjo lahko dosežemo enak ali podoben rezultat merjene ali izračunane količine.

Accuracy is the degree of closeness of a quantity's measurements or calculations to that quantity's actual (true) value. Hence it signifies the reliability of the measured or calculated quantity. Concerning geospatial data, accuracy is the criterion as to what extent the data, for instance, in the plan (e.g., the geographical position), matches the values in the real world.

Precision is the degree to which repeated measurements or calculations show the same or similar results. Precision, therefore, signifies the degree to which the same or similar result of the measured or calculated quantity can be reproduced.

10.5 GEODEZIJA IN INŽENIRSTVO – HE PLAVE

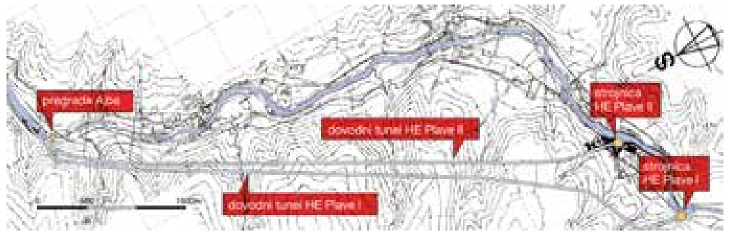
GEODESY AND ENGINEERING – PLAVE HPP TUNNEL

HE Plave I je bila zgrajena v času italijanske okupacije Primorske (1936-1940) skupaj s HE Doblar. Elektrarni sta bili takrat najmodernejši na območju Slovenije in sta skupaj pokrivali 40 % potreb po električni energiji.

Gradnja HE Plave II se je pričela v letu 1997, zaključila pa se je leta 2001, ko je pričela s poskusnim obratovanjem.

The Plave I HPP was built during the Italian occupation of Primorska (1936-1940) together with the Doblar HPP. The two power plants, which were the most modern in Slovenia at the time, supplied 40 % of the country's electricity needs.

Construction of the Plave II HPP started in 1997 and was completed in 2001, when the trial operation began.



Osnovna geodetska mreža dovodnega predora HE Plave II, ki omogoča projektiranje in kasnejšo gradnjo, je prva taka geodetska mreža v Sloveniji, izmerjena s tehnologijo GNSS. Pri vzpostavitvi mreže je bilo potrebno veliko novega znanja, saj je nova tehnologija za dosego tako visoke zahtevane točnosti izmere vse prej kot enostavna. Toliko težje je to bilo pred dobrimi 20 leti.

The base geodetic network of the Plave HPP intake structure, a reliable primary network on which design and future construction are based, is the first such geodetic network in Slovenia calculated by using GNSS technology. Its establishment necessitated advanced knowledge due to the complexity of the new technology in achieving such a high degree of accuracy in measurements. An objective that had been all the more challenging twenty years earlier.

Za izmero so uporabili sedem sprejemnikov GNSS Trimble 4000 SSE in tri Trimble 4000 SSi. Izmera je trajala tri dni, vsakič po 10 do 12 ur z intervalom 15". Mreža je definirana v lokalnem koordinatnem sistemu predora, točnost določitve horizontalnega položaja točk pa je bila v intervalu od 4 mm do 7 mm. Vrhunsko.

Seven Trimble 4000 SSE and three Trimble 4000 SSi GNSS receivers were employed. The surveying took three days, 10 to 12 hours per day at a 15-second recording interval. The network is defined in the local coordinate system of the tunnel. The horizontal positions of the points were determined within a 4 to 7 mm accuracy range. Excellent performance.

Osnovno mrežo GNSS dopolnjujeta portalni mreži. Nadvse pomembna je bila mreža ob iztoku, saj je bila osnova za zakoličbo operativnega poligona predora. Portalni trigonometrični mreži sta triangulacijsko trilateracijski.

Two portal networks complement the base GNSS network. The network at the Plave HPP outflow was crucial, serving as a basis for the stake out of the tunnel's traverse. The portal trigonometric networks are triangulation-trilateration nets.

Za izmero so uporabili najnatančnejšo mersko opremo tistega časa, to sta bila elektronski razdaljemer Kern ME 5000 in elektronski teodolit Kern E2. Dosežena natančnost horizontalnih koordinat portalne mreže je bila vrhunska, položajni pogreški so bili le nekaj desetink milimetra.

The surveying was performed with the high-end measuring instruments of the time, i.e., the Kern ME 5000 electronic distance meter and the Kern E2 electronic theodolite. The accuracy of the horizontal coordinates in the portal network was exceptional, with a determination error of only a few tenths of a millimetre.

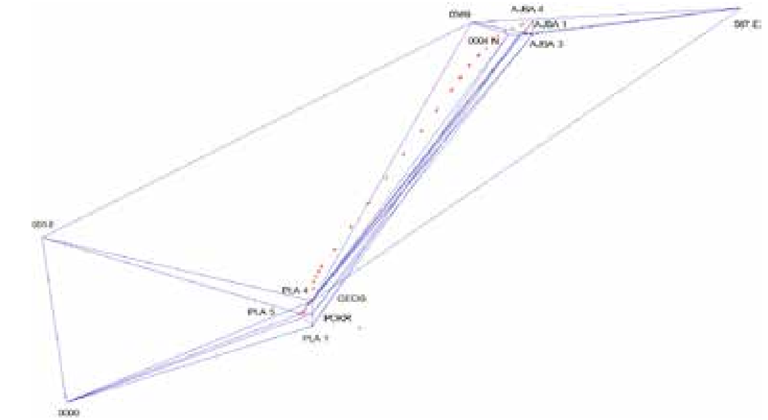
Laserska usmerjevalna naprava na zadnji točki operativnega poligona.
Alignment laser at the endpoint of the main traverse.

Predor so vrtali s sodobno tehnologijo TBM. Vrtalni stroj istočasno vrta celotni profil predora in ga obloži z betonskim ovojem. Stroj dolžine skoraj 200 m je treba usmerjati na projektirano smer.

Zakoličevanje položaja stroja je ključna naloga. Osnova je portalna mreža. Z razvijanjem operativnega poligona, ki ima obliko slepega poligona, smer prenašamo iz portalne mreže do stroja vedno znova, dan za dnem. To je naloga geodeta, ki je pri izvajalcu del. Občasno je v izogib grobim napakam potrebna neodvisna kontrola izmere.

The excavation works were executed by a tunnel boring machine (TBM), which can dig a full-face tunnel underground, while simultaneously lining it with concrete segments. Almost 200 m long machine has to be guided in the design direction.

Precise staking out of the machine position is critical. It is based on the portal network, which is used to constantly, day after day, transfer the direction of boring of the tunnel structure to the underground open traverse. This task is the responsibility of the surveyor employed with the contractor. From time to time, to eliminate or minimize errors that cannot be compensated for, an independent measurement verification is necessary.



Osnovna in portalna mreža z operativnim poligonom.
Basic and portal network with the main traverse.

Položaj vrtalnega stroja je bil 200 metrov pred dokončanjem vrtanja ob vtoku kontroliran z enkratno izmero operativnega poligona. Uporabili so dva precizna elektronska tahimetra, in sicer Leica Wild TC2002 in Leica TC2003.

Natančnost preboja po položaju je bila 300 mm, v vertikalni smeri je bila 10 mm.

Two hundred metres before the breakthrough, the traverse coordinates at the intake were controlled by precise electronic tacheometers Leica Wild TC2002 and Leica TC2003.

Breakthrough precision was 300 mm transverse and 10 mm vertical deviation.

10.6 GEODEZIJA IN INŽENIRSTVO – INDUSTRIJSKA MERJENJA

GEODESY AND ENGINEERING – INDUSTRIAL MEASUREMENTS

[84]

V zadnjih letih velike proizvodnje tovarne, predvsem v avtomobilski industriji, uvajajo procese oskrbe materiala z avtomatsko vodenimi vozički (Automated Guided Vehicle – AGV). To pomeni, da material, ki ga delavci potrebujejo za sestavo avtomobila, ali polizdelki, ki jih naredijo roboti, avtomati in preše, samodejno potujejo na pravo mesto ob pravem času. Vozički delujejo brez operaterja 24 ur na dan.

Large manufacturing plants, especially in the automotive industry, have increasingly introduced Automated Guided Vehicle (AGV) as an efficient material handling solution. The materials that workers need to assemble a car, or the semi-finished products made by robots, machines, and presses, automatically travel to the right place at the right time. The carts work autonomously 24 hours a day without the need for a human operator.

Navigacija poteka po principu sledenja traku, ki je pritrjen na tleh, ali s pomočjo navigacije, ki jo sproti določa računalniška oprema na podlagi laserskega skeniranja sidranih magnetnih točk. Za koordinacijo in nadzor skrbi računalniški sistem, ki je narejen na podlagi natančnih predhodnih meritev proizvodnih prostorov.

AVGs can follow the guide tapes on the floor (including magnetic tapes or magnetic bars embedded in the floor) or use lasers for navigation. Another form of guidance is inertial navigation, where a computer control system directs the vehicles. Computer software provides coordination and control based on precise preliminary measurements of the production area.

Geodezija je prisotna tudi pri industrijski avtomatizaciji, kjer ima pomembno vlogo pri zajemu podatkov in izvajanju podatkovno vodenih procesov. Tehnologija samodejnega merjenja je postala nenadomestljiva pri avtomatiziranju nadzora procesov v industriji. Procesne inovacije in razvoj merske opreme so meritve kakovosti iz laboratorijskega okolja pomaknile bližje proizvodni liniji, kar omogoča časovno optimizacijo od zagona proizvodnje do zbiranja podatkov o kakovosti ključnih elementov končnega izdelka in pravočasno ukrepanje pri odpravljanju pomanjkljivosti. Proizvodno osebje in kontrolorji kakovosti tako skoraj v realnem času pridobijo dostop do pregleda celotne geometrije in površine izdelkov in s tem celovitejšo oceno kakovosti proizvodne linije. [85]

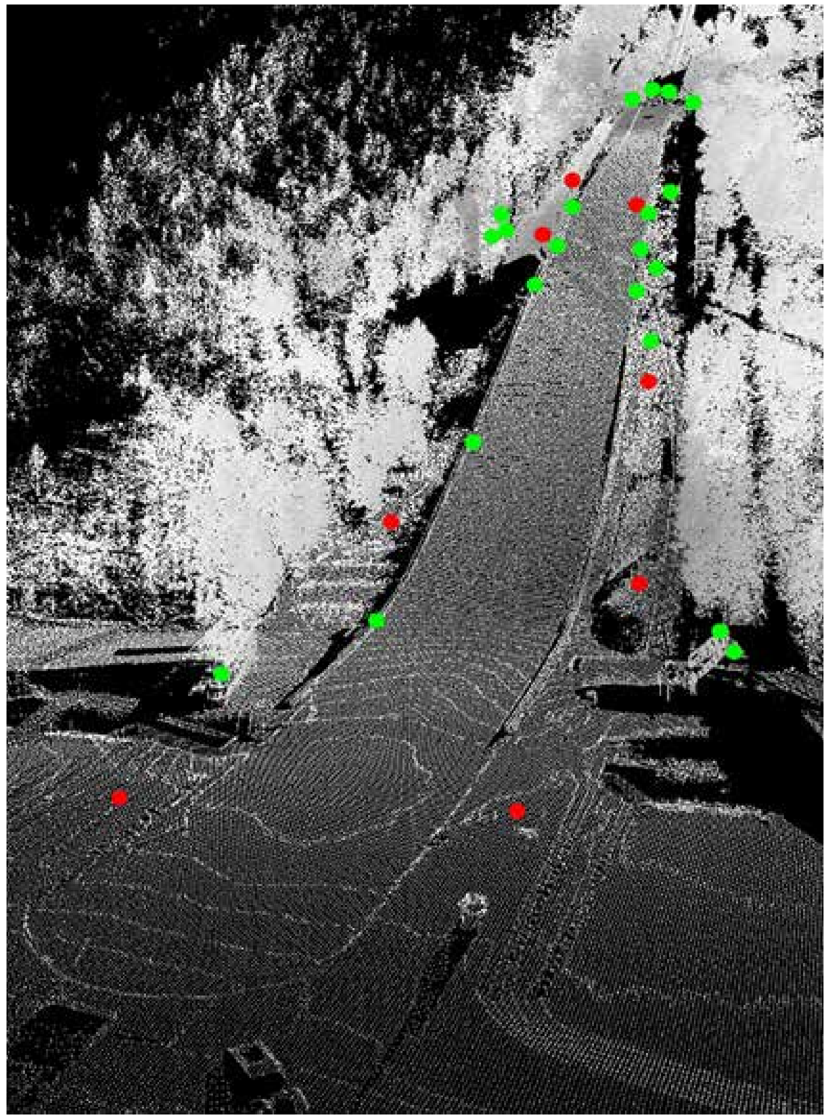
In industrial automation, geodesy plays a vital role in data acquisition and data-driven processes. Automated measurement technology has become an indispensable element in automatizing processes control in the industry. Process innovations and the development of measurement equipment have moved quality measurement from the laboratory closer to the production line, thus optimising time from the start of production to the quality evaluation of critical components of the final product and enabling timely intervention in addressing potential flaws or deviations. Production and quality control personnel gain nearly real-time access to the results of the geometrical and surface checks on products and, consequently, a more comprehensive evaluation of the production's line quality.

10.7 GEODEZIJA IN ŠPORT – PLANIŠKA VELIKANKA

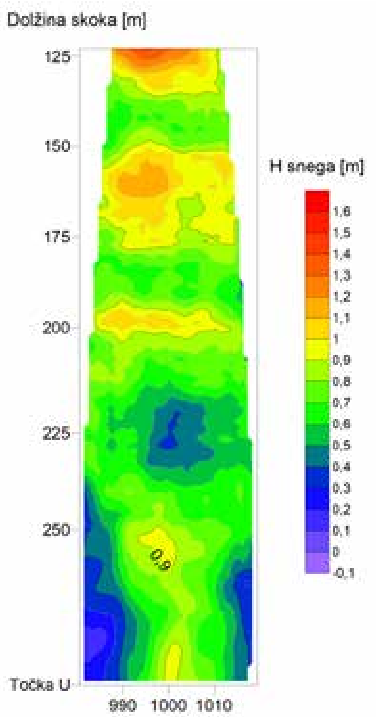
GEODESY AND SPORT – PLANICA GIANT HILL

Geodeti so več let zapored analizirali geometrijo snežnega profila letalnice v Planici. Merili so obliko in debelino snežne podlage, kar prispeva h kakovostni pripravi zaletišča in doskočišča skakalnice. Na dolžino skoka lahko namreč vpliva tudi višina snežne podlage na doskočišču. Za merjenje so uporabili tehnologijo terestričnega laserskega skeniranja (Terrestrial Laser Scanning – TLS).

The surveyors analysed the geometry of Planica flying hill's snow profile for several consecutive years. They measured the geometry and depth of the snow surface, which contribute to the quality preparation of both the inrun and the landing slope. Indeed, the surface snow depth at the landing slope can also affect the jump length. Measurements were performed by terrestrial laser scanning technology (TLS).



Oblak točk terestričnega laserskega skeniranja z oslonilnimi točkami.
The terrestrial laser scanning point cloud with control points.



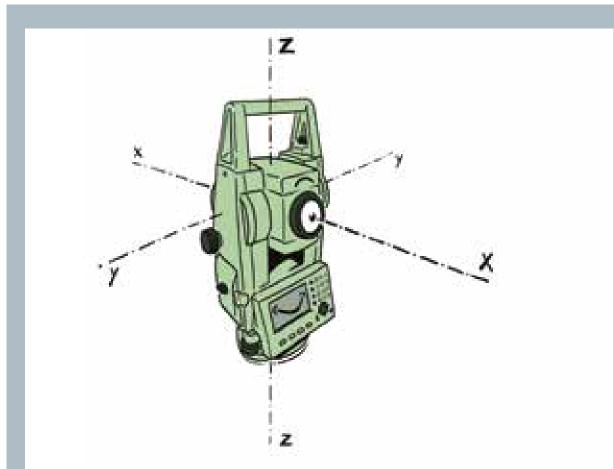
Debelina snežne podlage v času tekem svetovnega pokala leta 2018.
Snow surface thickness during the 2018 World Cup competition.

Debelina oziroma višina snega je določena iz razlik ploskev kopne letalnice in letalnice, pripravljene za tekmovanje. Iz prikaza izolinij je razvidno, da je bila snežna podlaga na večini doskočišča debela med 0,3 in enim metrom. Na debelino snežne podlage ima velik vpliv plazenje zemljine na doskočišču.

Večina smučarskih skakalcev pristaja pod kotom med šestimi in osmimi stopinjami na snežno podlago. Če bi Rjoju Kobajaši ob rekordnem poletu 252 metrov pristal na 15 centimetrov tanjši snežni podlagi, bi bil njegov polet več kot meter daljši.

The snow thickness or height is determined by the difference between the surfaces of the free-of-snow flying hill and the competition hill. The isolines show that the snow surface on most of the landing slope was between 0,3 and 1 metre thick. The thickness of the snow is strongly influenced by mass wasting on the landing slope.

Most ski jumpers land at an angle between 6 and 8 degrees to the snow surface. If Ryōyū Kobayashi had landed on 15 centimetres thinner snow on his record-breaking flight of 252 metres, his flight would have been more than a metre longer.



Tahimeter
Instrument za izvajanje terestrične geodetske izmere, natančno merjenje horizontalnih in vertikalnih kotov in poševnih dolžin.

Tacheometer
An instrument for measuring horizontal and vertical angles and oblique length on the earth's surface.

10.8 GEODEZIJA V KMETIJSTVU IN GOZDARSTVU

GEODESY IN AGRICULTURE AND FORESTRY

Kmetijska in gozdarska panoga, ki sta močno odvisni od vremenskih razmer, večinoma obsegata veliko območje. Klasični, ročni postopki spremljanja in analiziranja lastnosti določenega območja so zato zelo zamudni in ne omogočajo pravočasnega ukrepanja. Z različnimi metodami daljinskega zaznavanja lahko v relativno kratkem času zajamemo velike površine in v primeru naravnih ujm ali bolezni pravočasno ukrepamo.

Za te namene se največkrat uporabljajo visoko ločljivi večspektralni satelitski posnetki ter multispektralno ali hiperspektralno fotografiranje.

Z daljinskim zaznavanjem lahko:

- ločimo vrste rastlin,
- ugotavljamo zdravstveno stanje rastlin,
- spremljamo sušo,
- odkrivamo napad škodljivcev in rastišča tujerodnih invazivnih vrst,
- kontroliramo upravičenost kmetijskih subvencij.

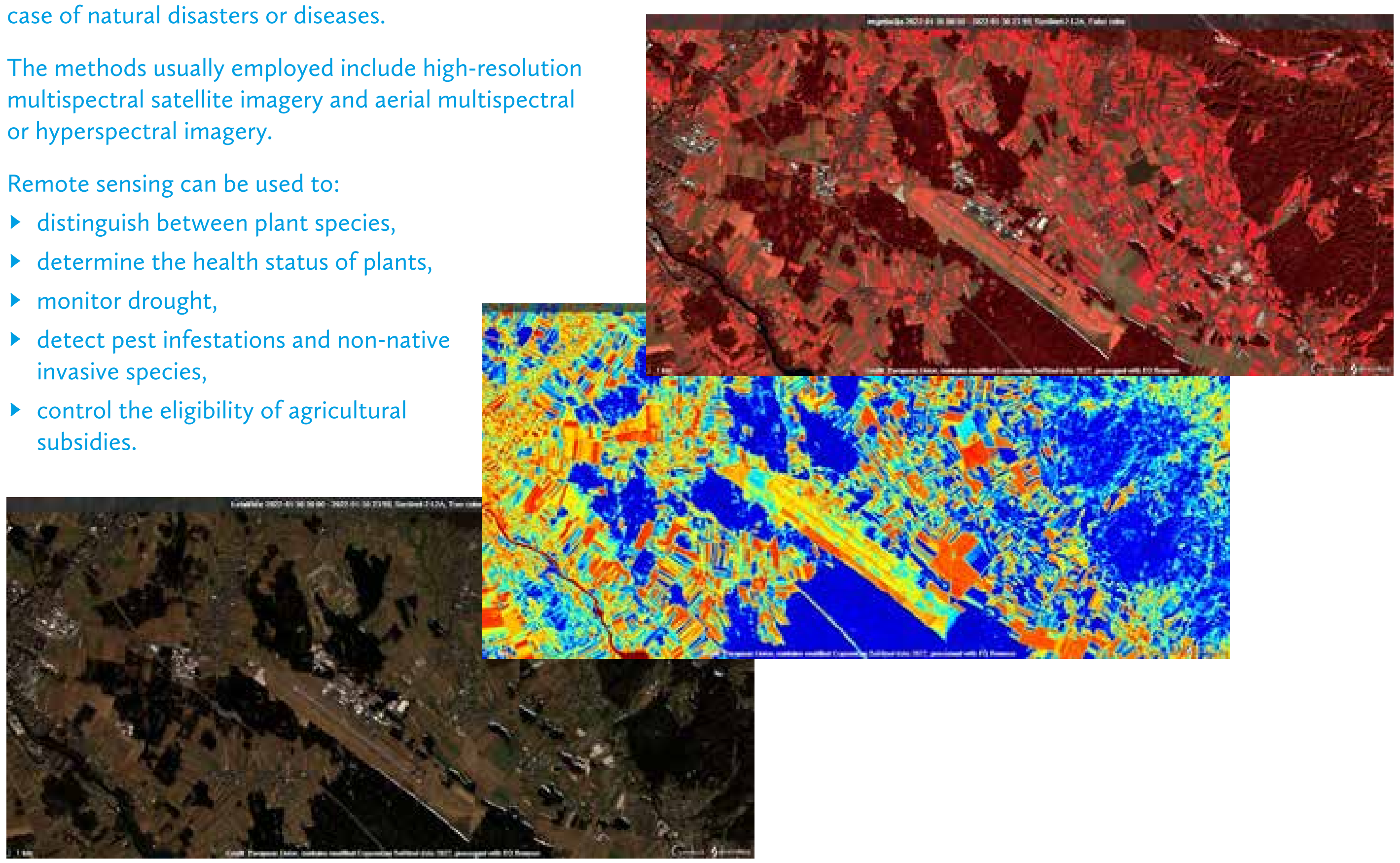
Highly dependent on weather conditions, the agricultural and forestry sectors typically cover large areas. Traditional manual methods of monitoring and analysing the properties of a specific area are time-consuming and do not allow for timely action. Various remote sensing methods facilitate capturing large areas relatively quickly, thereby providing valuable information for effective decision-making and timely response in case of natural disasters or diseases.

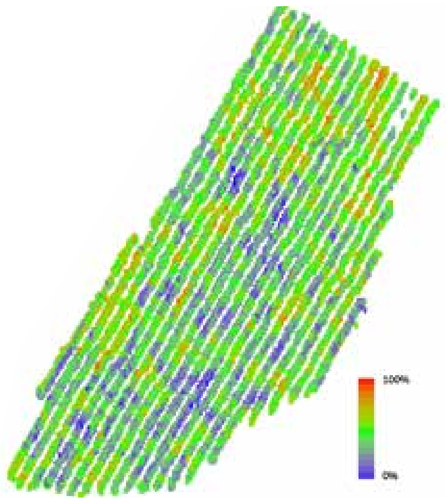
The methods usually employed include high-resolution multispectral satellite imagery and aerial multispectral or hyperspectral imagery.

Remote sensing can be used to:

- distinguish between plant species,
- determine the health status of plants,
- monitor drought,
- detect pest infestations and non-native invasive species,
- control the eligibility of agricultural subsidies.

Večspektralni satelitski posnetki.
Multispectral satellite imagery.





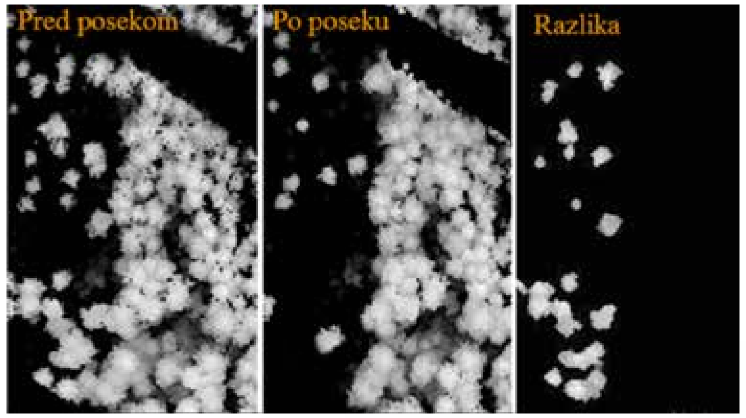
Verjetnosti okužbe vinske trte z zlato trsno rumenico.
Chances of vine infection with Flavescence dorée.

Z zračnim laserskim skeniranjem v kombinaciji z multispektralnim fotografiranjem in drugimi prostorskimi podatki lahko tudi analiziramo različne parametre gozda:

- sestava, višina in gostota gozda,
- lesna zaloga,
- svetlobne razmere,
- nadzor posekov,
- zaznavanje stopnje in obsega posledic naravnih nesreč.

Airborne laser scanning combined with multispectral imaging and other spatial data can be used in the analysis of various forest parameters, such as:

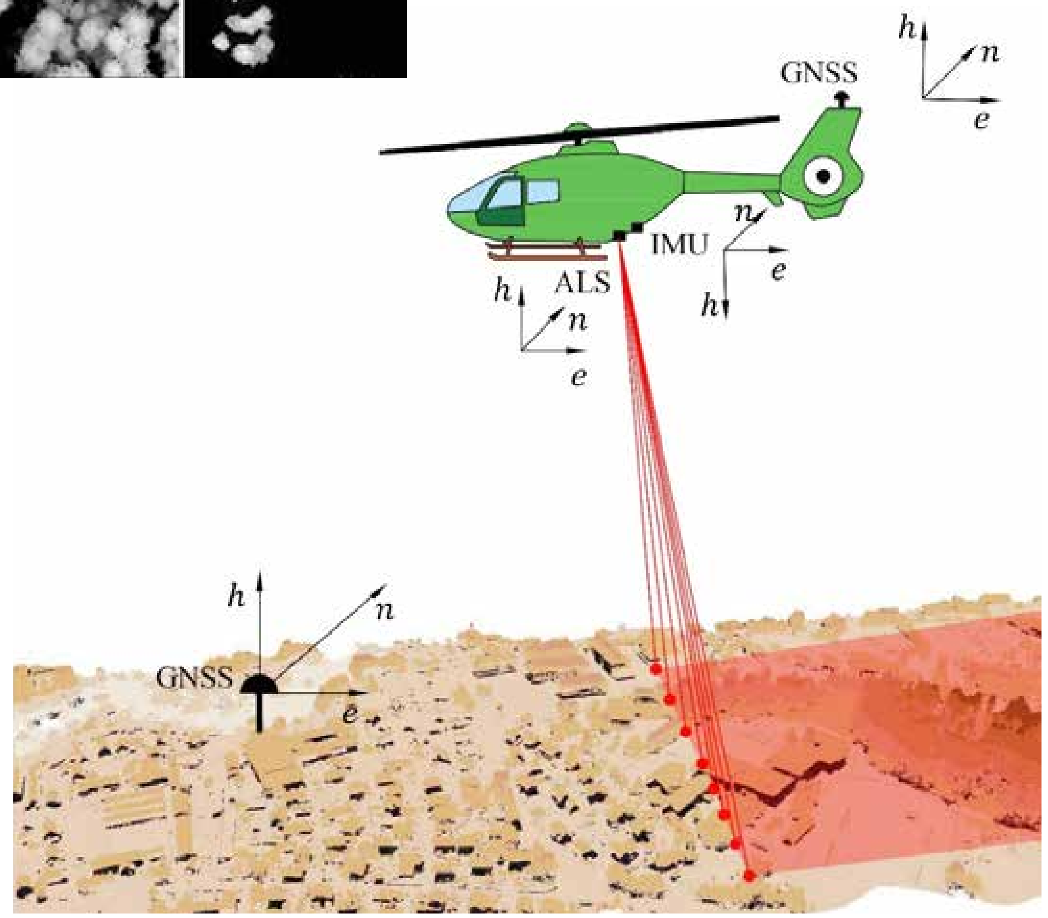
- the composition, height, and density of the forest
- the timber stock,
- light conditions,
- harvesting operations,
- the levels and extent of the effects of natural disasters.



Nadzor posekov.
Control of removals.

S skenerjem merimo kote in razdalje do posameznih točk skeniranega površja. Povezava z GNSS sprejemnikom in inercialno enoto (Inertial Measurement Unit – IMU) omogoča določitev lege točk v izbranem koordinatnem sistemu.

The scanner measures angles and lengths to individual points on the scanned surface. The connection to a GNSS receiver and an IMU inertial unit allows to specify the position of points in the selected coordinate system.



Aero lasersko skeniranje (Airborne Laser Scanning – ALS) terena. Prikaz senzorjev za orientacijo in pozicioniranje skeniranih točk.
Airborne laser scanning (ALS) of terrain (orientation and positioning sensors).

10.9 VLOGA GEODEZIJE PRI OHRANJANJU KULTURNE DEDIŠČINE

GEODESY AND THE PRESERVATION OF CULTURAL HERITAGE

Za ohranjanje kulturne dediščine je potrebno sodelovanje med javnimi in zasebnimi deležniki in uporaba primernih metod za identifikacijo, dokumentiranje, preučevanje in interpretacijo. Geodezija ponuja vrsto metod, ki so zelo primerne, saj gre povečini za metode brezkontaktnega merjenja in pridobivanja merskih in vizualnih podatkov ter pridobivanje množice podatkov v kratkem času.

Klasična geodezija je uporabna za klasično dokumentacijo (npr. v arheologiji), pa tudi za merjenje kulturnih objektov v naravi in pozicioniranje v prostor in načrte. Z natančnimi merskimi podatki predmetov ali nepremičnin lahko naredimo sosledje dogodkov in si olajšamo interpretacijo zgodovine.

Preserving cultural heritage requires collaboration between public and private stakeholders and the use of appropriate methods for identification, documentation, study, and interpretation. Geology offers a variety of highly suitable methods because they primarily involve non-contact measurement and data acquisition (both dimensional and spatial), plus the collection of a large amount of data in a short period.

Classical geodesy provides valuable tools for traditional documentation, such as in archaeology, and measuring cultural objects in the field and their positioning in space and plans. The precise measurement data of objects and properties enables the establishment of historical sequences and facilitates a deeper understanding and interpretation of history.

Izmera starejšega železnodobnega groba na arheoloških izkopavanjih na Kapiteljski njivi (Novo mesto, 2009).

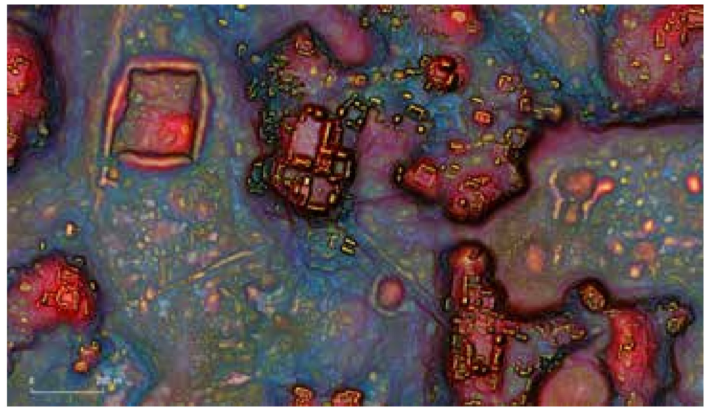
Measurement of an older Iron Age grave during archaeological excavations at Kapiteljska njiva (Novo mesto, 2009).

Najvišji kres na svetu so postavili krajani Boštanja 30. aprila 2007, s čimer so se vpisali v Guinnessovo knjigo rekordov. Geodet je izmeril višino s centimetrsko natančnostjo, in sicer 43,44 m.

The world's tallest bonfire, 43.44 m high, was built by the inhabitants of Boštanj on 30 April 2007, thus entering the Guinness Book of World Records.

Snemanje LiDAR (Light Detection and Ranging – LiDAR)
Gre za lasersko skeniranje, eno od tehnik daljinskega zaznavanja, ki je bila razvita predvsem za vojsko, vendar se že 25 let uspešno uporablja za zajem različnih 3D podatkov o prostoru. Laserski instrument proti merjenemu objektu pošlje laserski žarek in izmeri njegov odboj. Instrument je sestavljen iz oddajnika laserskih žarkov in sprejemnika odbitih žarkov. Žarki gredo skozi vegetacijo in posnamejo strukturo površja, tako da s to metodo pridobimo podatke o površini oz. obliki terena. S temi metodami so v poraščenih gozdovih Mezoamerike našli nova arheološka najdišča, pri čemer je sodeloval tudi slovenski arheolog dr. Ivan Šprajc.

LiDAR (Light Detection and Ranging) is one of the remote sensing techniques. Although developed primarily for military applications, it has been successfully used for 25 years to capture various 3D spatial data. The instrument emits laser pulses and measures the time it takes for the reflected pulses to return to the sensor. It consists of a laser transmitter and a receiver for detecting the reflected beams. The beams penetrate through the vegetation canopy and record the structure of the surface below, providing data on the topography and surface characteristics of the area. These methods have been employed to discover new archaeological sites in the forests of Mesoamerica. Slovenian archaeologist Dr. Ivan Šprajc has also participated in the expeditions.



Fotogrametrija
Je veda, ki se ukvarja s pridobivanjem metričnih podatkov o objektu iz fotografskih posnetkov. Končni izdelek je lahko fotografija, oblak točk ali 3D model objekta. Ločimo topografsko fotogrametrijo, katere glavni cilj je izdelava topografskih načrtov in kart, ter bližnjeslikovno fotogrametrijo, kamor vključujemo tudi arhitekturno fotogrametrijo. Njen osnovni namen je, da se s fotogrametričnimi in geodetskimi meritvami dopolnijo, obnovijo ali izdelajo načrti obstoječih zgradb, ruševin, poslikav ipd. Ker so fotogrametrični postopki neinvazivni in nikakor ne posegajo v strukturo ali površino opazovanih objektov, so zelo primerni za ohranjanje kulturne dediščine. Pri tovrstnih postopkih vedno naredimo fotografije, ki se med seboj delno prekrivajo, in nadštevilna geodetska merska opazovanja na točkah objekta, ki so tudi vidno zajeta na fotografijah.

Photogrammetry
It is a science that deals with obtaining metric data about an object from photographs. The final product can be a photograph, a point cloud or a 3D model of an object. We distinguish between topographic photogrammetry, the main goal of which is the production of topographic plans and maps, and closeup photogrammetry, which also includes architectural photogrammetry. The basic purpose of this is to supplement, restore or make plans of existing buildings, ruins, paintings, etc. with photogrammetric and geodetic measurements. Because photogrammetric procedures are non-invasive and do not interfere in any way with the structure or surface of the observed objects, they are very suitable for the preservation of cultural heritage. In such procedures, we always take photographs that partially overlap each other and numerous geodetic measurement observations at points on the building, which are also visibly captured in the photographs.

3D model enoceličnega panja v obliki vojaka iz obdobja med poznim 18. in prvo tretjino 19. stoletja. Original hrani Posavski muzej Brežice. 3D model čebelnjaka, ki je bil narejen s fotogrametričnimi postopki, je namenjen preučevanju kulturne dediščine kot tudi izdelavi replike v naravni velikosti.

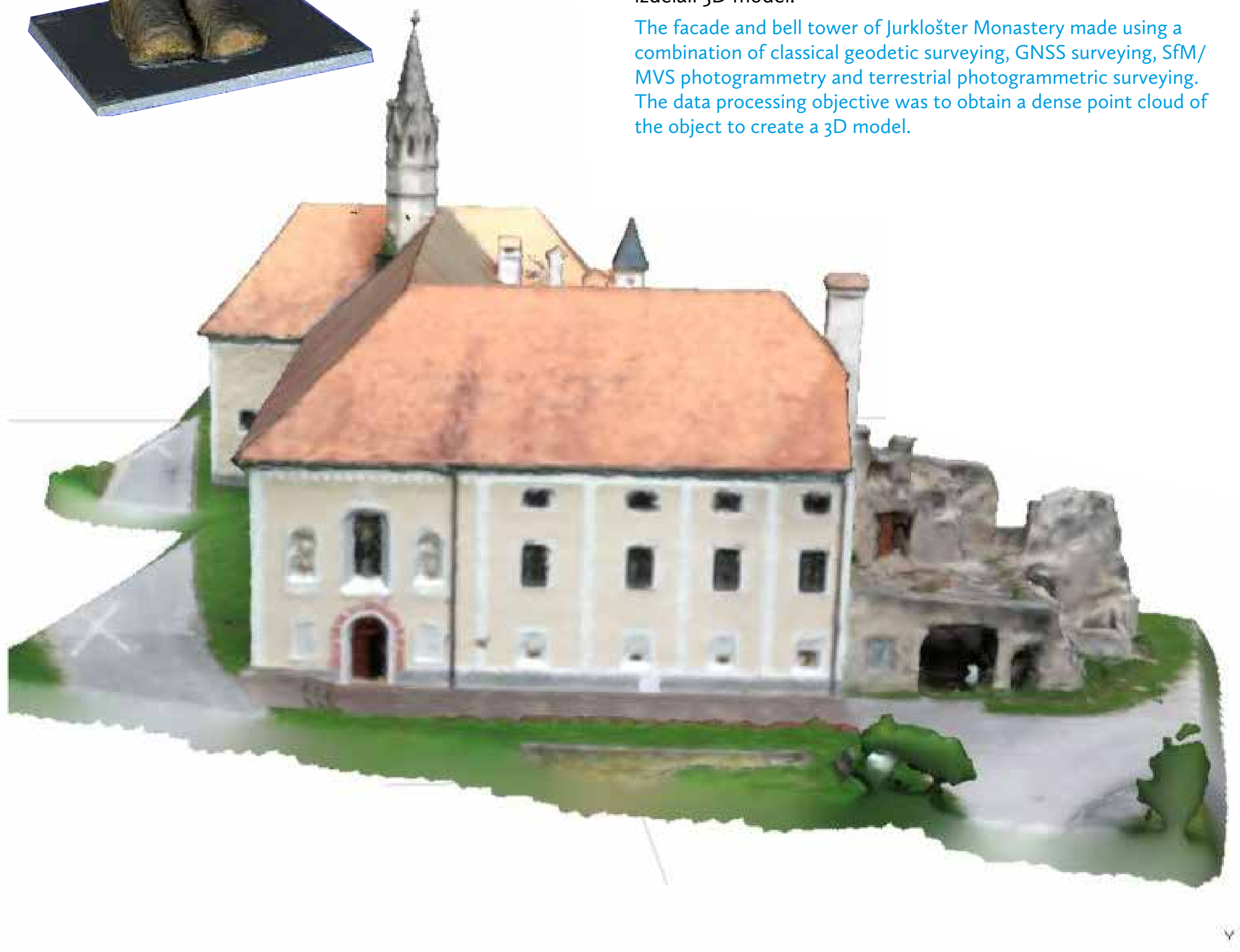
A 3D model of a single-celled hive in the shape of a soldier from the late 18th or first third of the 19th century. The original is kept at the Posavje Museum Brežice. The 3D model of the beehive, made using photogrammetry, is aimed at studying cultural heritage and creating a life-size replica.

Terestrična analogna fotogrametrična kamera UMK 10/1318 (Carl Zeiss Jena).

Terrestrial photogrammetric camera.

Pročelje in zvonik samostana Jurklošter (nepremične kulturne dediščine), narejena z uporabo kombinacij metod klasične geodetske izmere, izmere GNSS, SfM/MVS fotogrametrije in terestrične fotogrametrične izmere. Cilj obdelave meritev je bil pridobiti gosti oblak točk objekta, na osnovi katerega bi lahko izdelali 3D model.

The facade and bell tower of Jurklošter Monastery made using a combination of classical geodetic surveying, GNSS surveying, SfM/MVS photogrammetry and terrestrial photogrammetric surveying. The data processing objective was to obtain a dense point cloud of the object to create a 3D model.

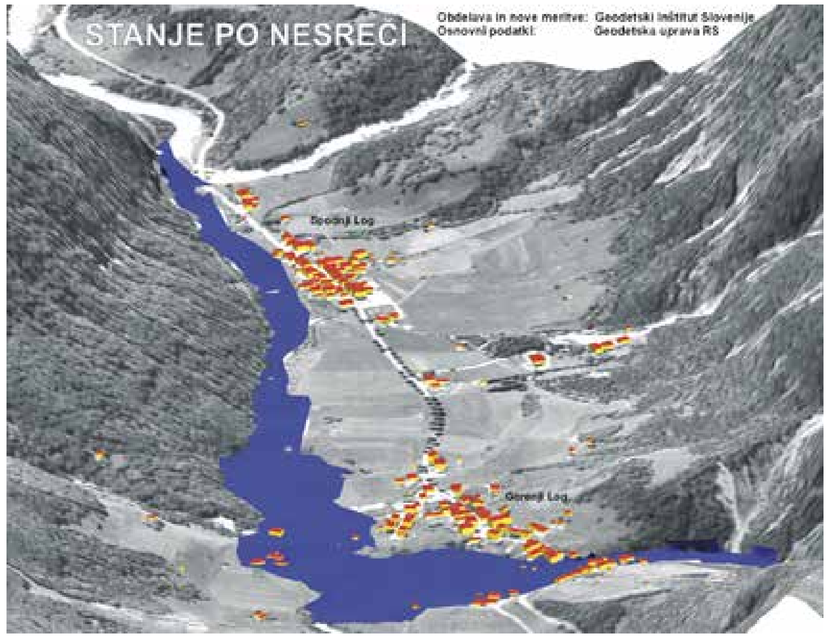


10.10 EKOLOGIJA

ECOLOGY

V Sloveniji so najbolj pogoste naravne nesreče poplave, zemeljski plazovi, toča in suše. Naravne nesreče so nepredvidljive in zahtevajo takojšnje ukrepanje. Najrazličnejši geodetski podatki (ortofotografije, digitalni model reliefa, kataster stavb, zemljiški kataster) so osnova za lažje odločanje o potrebnih preventivnih ukrepih. Uporaba različnih tehnik daljinskega zaznavanja (fotogrametrija, LiDAR, satelitski posnetki) omogoča takojšnjo izmero prizadetega območja, oceno nastale škode in pripravo strokovnih podlag za nadaljnje ukrepanje.

The natural disasters that commonly strike Slovenia are floods, landslides, hailstorms, and droughts. Natural disasters are unpredictable and require immediate action. A wide range of geodetic data (orthophotos, digital terrain model, building cadastre, land cadastre) provides the basis that facilitates decision-making regarding the necessary preventive measures. Employing various remote sensing techniques such as photogrammetry, LiDAR, and satellite imagery provides prompt and precise measurement of the affected area and assessment of the extent of damage and enables the authorities, dedicated services and professionals to prioritise future actions.

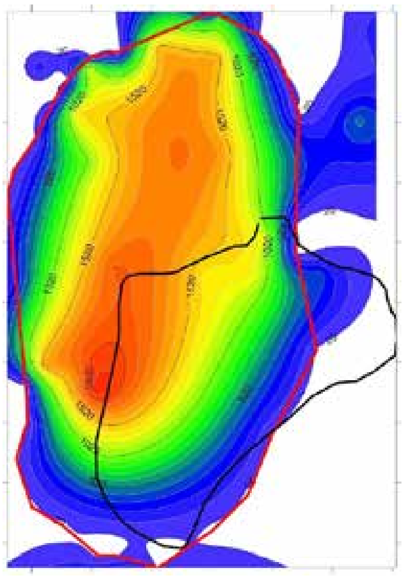


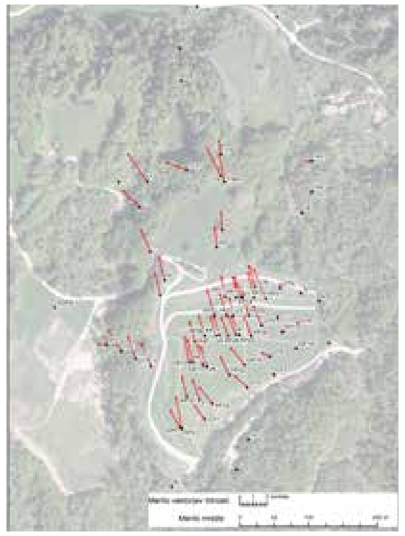
V sredini novembra leta 2000 sta se nad vasjo Log pod Mangartom, ki ga sestavljata zaselka Spodnji in Gorenji Log in ležita na nadmorski višini med 620 m in 650 m, sprožila dva zemeljska plazova. Prvi (15. 11. 2000) ni ogrozil vasi, drugi (17. 11. 2000) pa je močno prizadel Gorenji Log. Plaz je povzročil veliko materialno škodo in vzel tudi človeška življenja.

19. 11. 2000 je z vojaškim helikopterjem nad prizadeto območje odletela ekipa strokovnjakov, da izvede interventno fotogrametrično snemanje iz helikopterja. Potrebno je bilo takojšnje ukrepanje, časa za pripravo snemanja praktično ni bilo. Cilj fotogrametričnega snemanja je bil predvsem čim hitreje metrično dokumentirati prizadeto območje in izdelati načrte, ki so jih drugi strokovnjaki nujno potrebovali za svoje delo in analize (hidrotehniki, geologi idr.). Snemalec je bil pripet z varnostnimi pasovi in se je pri odprtih vratih nagnil, da je v objektiv metrične kamere Rolleiflex 6006 zajel želeno območje.

Celotna akcija je bila veliko širša in je vključevala tudi druge stroke in terenske geodetske meritve za potrebe spremljanja premikov plazu.

In mid-November 2000, two landslides occurred above the village of Log pod Mangartom, comprising two settlements, Spodnji Log and Gorenji Log, located between 620 and 650 metres above sea level. The first landslide on 15 November wasn't a threat to the village, while the second two days later severely affected Gorenji Log causing extensive damage to property and taking human lives.



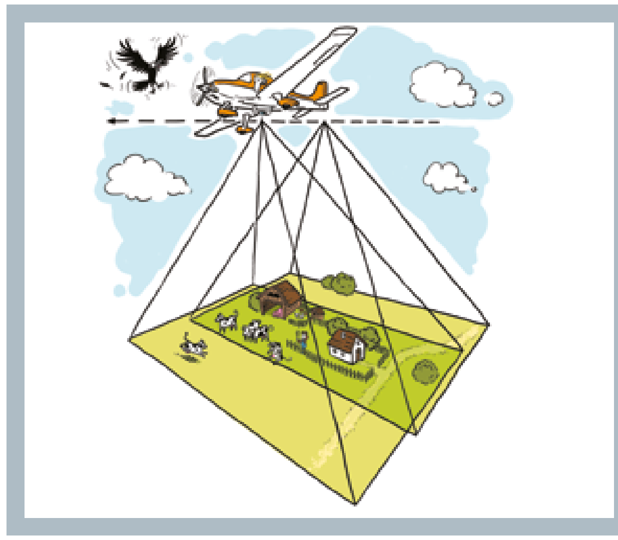


On 19 November 2000, a team of experts flew over the affected area with a military helicopter to conduct an emergency photogrammetric aerial survey. The situation required immediate action, and the crew had no time to prepare. The objective of the survey was primarily to quickly document the affected area with metric accuracy and produce plans that other experts, such as hydraulic engineers, geologists, and others, urgently needed for their work and analyses. Securely fastened with safety belts, the cameraman leaned out of the open doors of the helicopter, aiming the metric camera (Rolleiflex 6006) at the designated area.

The overall campaign was broader, involving other disciplines and field surveying to monitor landslide movements.

Odlagališče hidrometalurške jalovine rudnika Žirovski vrh je objekt, ki potuje v dolino.
To je bilo pred leti občutno, zdaj pa je zaznavno le z natančnimi geodetskimi meritvami.

The hydrometallurgical waste depository of the Žirovski vrh uranium mine slides downhill. Quite substantial in the past, the sliding is now only detectable with precise geodetic measurements.



DOF digitalni ortofoto

Ortofoto je aerofotografija, ki je z upoštevanjem podatkov o reliefu in absolutne orientacije aerofotografij pretvorjena v ortogonalno projekcijo. V metričnem smislu je izdelek enak linijskemu načrtu ali karti.

DOF digital ortophoto

An orthophoto is a geometrically corrected aerial image in which absolute orientation of the image and digital terrain model data is used for the orthorectification. In a metric sense, it is comparable with vector maps.

11 ZNANOST IN RAZVOJ / SCIENCE AND DEVELOPMENT

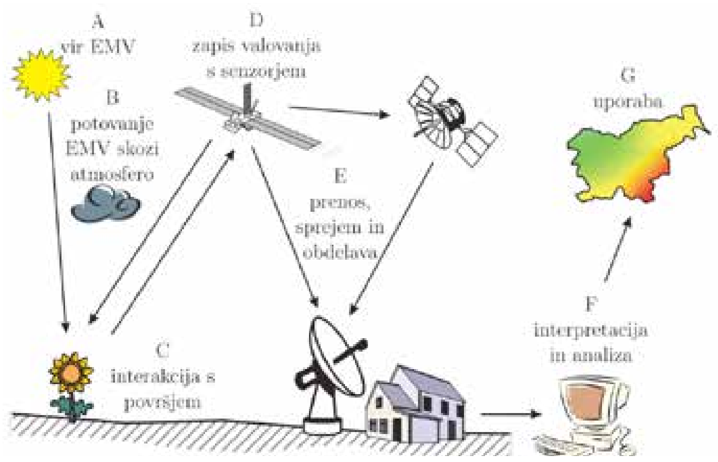
11.1 DALJINSKO ZAZNAVANJE

REMOTE SENSING

Danes je to hitro razvijajoče se področje, ki združuje različne tehnologije, kot so digitalna fotografija, lasersko skeniranje, optični in radarski satelitski snemalni sistemi, mobilni merski sistemi, brezpilotni sistemi za snemanje ipd.

Daljinsko zaznavanje je veda o zajemanju lastnosti predmetov ali območja brez stika med predmetom in senzorjem. Zaznava in zapisuje se odbita ali sevana energija predmetov. Združuje različne tehnologije:

- digitalno fotografijo – ortofoto,
- lasersko skeniranje ali LiDAR,
- optične in radarske satelitske snemalne sisteme,
- mobilne merske sisteme,
- brezpilotne sisteme.



Slika principa daljinskega zaznavanja.
Remote sensing principle.

Today, remote sensing is a rapidly evolving field that combines various technologies such as digital photography, laser scanning, optical and radar satellite imaging, mobile measurement system, unmanned systems, and more.

It is the process of detecting the physical characteristics of an object or area without making physical contact by measuring its reflected or emitted radiation.
Remote sensing combines different technologies:

- digital photography – orthophoto,
- laser scanning or LiDAR,
- optical and radar satellite recording systems,
- mobile measurement systems,
- unmanned systems.

Oblak točk fotogrametričnega zajema površja.
Photogrammetric surface point cloud.

Med predmeti in valovanjem so možne tri vrste interakcij: odboj, absorpcija in transmisija. Optični senzorji merijo skupni učinek teh interakcij – odbojnost. Vsak predmet ima svojo značilno odbojnost, ki jo imenujemo spektralni podpis. Na podlagi spektralnega podpisa lahko identificiramo različne predmete in snovi.

Začetek satelitskega daljinskega zaznavanja predstavlja izstrelitev prvega civilnega satelita za opazovanje Zemlje (Landsat) leta 1972. Veliko prelomnico v razvoju predstavlja satelit IKONOS (1999), ki je prvi civilni visokoločljivostni satelitski sistem z ločljivostjo okrog 1 m v pankromatskem delu spektra.

Glavni izdelki so oblak točk, digitalni model površja, ortofoto in kot njihova nadgradnja 3D modeli mest in pokrajin.

Three ways that waves may interact with objects are reflection, absorption, and transmission. Optical sensors measure the combined effect of these interactions, which is called reflectance. All matter has different values of spectral reflectance characteristics known as a spectral signature, based on which we can identify various objects and matter.

The beginning of satellite remote sensing goes back to the launch of the first civilian Earth observation satellite, Landsat, in 1972. A massive breakthrough in the development of satellite remote sensing occurred with the launch of the IKONOS in 1999, the first civilian high-resolution satellite system with a spatial resolution of approximately 1 metre in the panchromatic portion of the spectrum.

The main products of remote sensing and geospatial data acquisition include point cloud, digital surface model, orthophoto, and, as their upgrade, 3D models of cities and landscapes.

Razvoj aerofotogrametrije pri nas:

- 1970 začetek snemanja v Sloveniji,
- 1985 redno snemanje v triletnih ciklih (ciklično aerosnemanje),
- 2003 prvi posnetki v barvni tehniki,
- 2006 aerofotografiranje vse Slovenije, z digitalnim aerofotoaparatom, v barvnem (RGB) in infrardečem spektru.

Običajno je velikost slikovnega elementa na terenu 0,25 m, kar ustreza dolžini talnega intervala (DTI).

Development of aerial photogrammetry in Slovenia:

- 1970: beginning of the aerial recording in Slovenia,
- 1985: regular recording in three-year cycles (cyclic aerial recording),
- 2003: first recordings in colour,
- 2006: aerial photogrammetry of entire Slovenia in colour (RGB) and infrared range.

Usually, the distance between pixels measured on the ground – ground sample distance (GSD) amounts to 0.25 m.

Ortofoto območja Krke, Tovarna zdravil d. d., Novo mesto.
Orthophoto of the Krka area, Tovarna zdravil d.d., Novo mesto.

1961

1975

1994

2006

2016

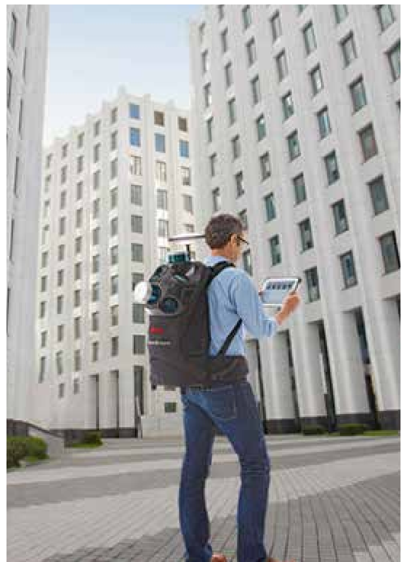
2021

11.2 GEODETSKA TEHNOLOGIJA IN MERJENJE V PRIHODNOSTI

SURVEYING TECHNOLOGY AND MEASUREMENTS IN THE FUTURE

Meritve in geodetske meritve so bile pomembne v starem Egiptu, ker so letne poplave zasule ali uničile mejne oznake, ki jih je bilo treba nato ponovno vzpostaviti, da bi preverili lastništvo polj.

Measuring and surveying were important in Ancient Egypt because the annual floods buried or destroyed boundary markers, which then had to be re-established to check ownership of the fields.



Geodezija pomaga človeku meriti prostor ter njegove spremembe skozi čas že tisočletja.

Tako kot vsaka dejavnost se tehnološko izboljšuje. Prehojena zgodovinska pot razvoja sega od merjenja dolžin z raztegovanjem vrvi v Starem Egiptu pa vse do najsodobnejših geodetskih merskih sistemov.

Hiter razvoj razširja osnovno definicijo geodezije kot znanosti merjenja in kartiranja zemeljskega površja v tehnološko napredno področje, ki omogoča merjenje relativnih odnosov objektov v prostoru. To merjenje se danes z visoko natančnostjo in točnostjo dogaja na globalni ravni, torej Zemlje kot planeta, ali pa na lokalnem območju, npr. del površja ali posamezni objekt.

Geodesy has been aiding humans in measuring space and its changes over time for thousands of years.

Like any field of activity, it has undergone technological advancements throughout history. Its development journey spans from stretching rope to measure distances in ancient Egypt to today's most advanced geodetic measurement systems.

Geodesy has evolved from traditional methods of surveying and mapping the Earth's surface to incorporate advanced technologies that enable measurements of relative positions and distances between objects in space. New technologies allow for highly accurate and precise measurements on a global scale, encompassing the entire planet Earth or locally, focusing on specific areas or individual objects.

Z napredkom v tehnologiji se razvijajo nova geodetska merilna oprema in merilne tehnike. Trendi razvoja kažejo v smer nadgrajevanja sistemov zajemanja merskih podatkov, avtomatizacije in povezovanja različnih merskih tehnologij z željo po vzpostavitvi prilagodljivejšega načina kreiranja prostorskih informacij. Klasični načini merjenja se in se bodo v prihodnosti v še večji meri prepletli s satelitskimi ter ostalimi multisenzorskimi sistemi. Izziv torej predstavlja uporaba sodobnih tehnologij v geodetski merski praksi. Uvajajo se nove stopnje robotizacije tahimetrov, ki pohitrijo merski proces in fizično razbremenijo operaterja. Posodabljajo se sistemi GNSS, ki zagotavljajo boljše obvladovanje najrazličnejših vplivov na določanje položaja na zemeljskem površju in s tem povečujejo natančnost pozicioniranja. Zelo intenzivno področje razvoja je uvajanje novih merskih tehnologij na področju laserskega skeniranja. Poleg terestričnih izvedenk se z razvojem in enostavnostjo uporabe dronov ta tehnologija prenaša tudi v zrak. Tako lahko hitro zajemamo geometrijo širših območij.

The advancement in technology materialises in new measuring equipment and techniques. The development trends point to upgrading data acquisition systems, automation, and integrating various measurement technologies to make the acquisition and processing of spatial data more flexible. In the future, classical methods will increasingly be combined with satellite and other multisensor systems. The challenge is thus the application of modern technologies in surveying practice. New levels of robotic automation are being introduced for tachymeters, speeding up the measurement and physically relieving the operator. GNSS systems are being updated to manage better various influences on determining position on the Earth's surface to increase positioning accuracy. A highly intensive development area is employing new measurement technologies in laser scanning. In addition to terrestrial applications, the development and easy use of drones foster the transfer of this technology to the aerial domain, allowing for rapid capture of the geometry of larger areas.

Vse našteto, vključno z izboljšavami na področju mobilnega 3D kartiranja in spremembami v upravljanju podatkov, kaže na to, da je geodezija pred vrati velikega razvoja in korenitih sprememb. Mej v tehnološkem razvoju praktično ni. Vse gre v smeri zajemanja ogromne količine merskih podatkov. V prihodnosti ne bo vprašanje kako izmeriti, ampak kako vso to ogromno količino podatkov obdelati, dobiti iskane količine ter jih ustrezno predstaviti in uporabljati.

Indeed, all of the mentioned advancements, including improvements in mobile 3D mapping and changes in data management, indicate that geodesy is on the verge of significant development and profound changes. There are virtually no limits to technological development. Everything points towards capturing vast amounts of measurement data. In the future, we will not deal with how to measure but rather how to efficiently process this massive data, extract valuable information and effectively communicate and utilise it.

12 IZOBRAŽEVANJE / EDUCATION

12.1 ŠOLSTVO DO 20. STOLETJA

EDUCATION UNTIL THE 20TH CENTURY

Izobraževanje za poklic zemljemerca sega na Slovenskem v 18. stoletje, ko sta na Kranjskem delovali dve šoli:

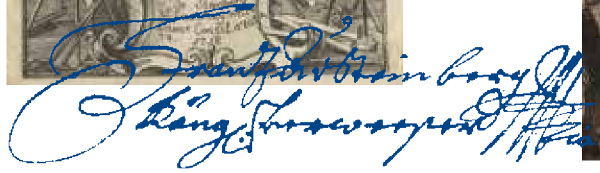
1. Steinbergova rudniška šola pri upravi rudnika živega srebra v Idriji, kjer je bil program prilagojen potrebam rudarstva, ter
2. Ljubljanski licej.

Education for the profession of a land surveyor in Slovenia dates back to the 18th century when in Carniola, schooling was provided by two schools:

1. the Steinberg mining school at the Mercury Mine Administration in Idrija, where the curriculum was adapted to the needs of the mining industry, and
2. the Ljubljana Lyceum.

FRANC ANTON STEINBERG (1684–1765), slikar, geograf, geometer.

FRANC ANTON STEINBERG (1684–1765) – a painter, geographer and surveyor.



JOŽEF MRAK (1709–1786), predavatelj zemljemerstva na idrijski rudniški in od 1763 do 1769 na metalurško-kemijski šoli.

JOŽEF MRAK (1709–1786) – a lecturer in surveying at the mining school in Idrija, and from 1763 to 1769 at the school of metallurgy and chemistry.

Skica idrijskega rudnika živega srebra in tloris Idrije (1770).

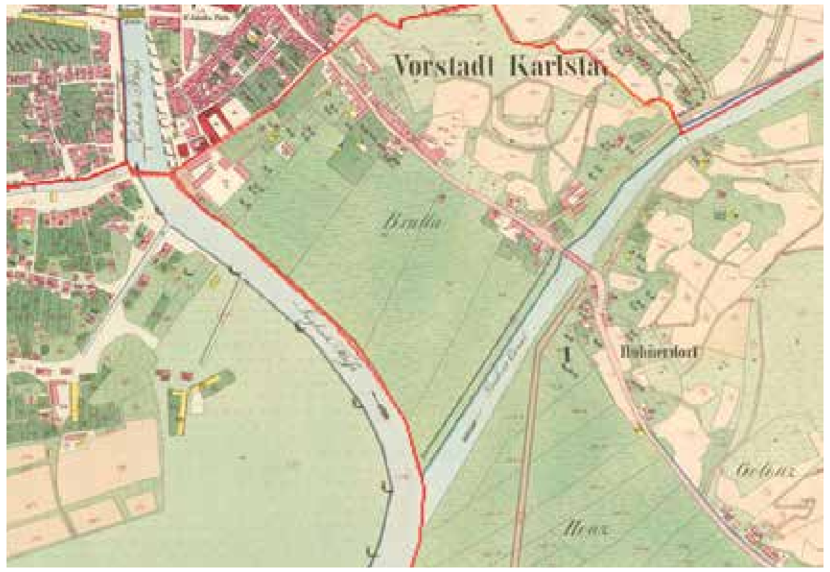
Sketch of the Idrija mercury mine and ground plan of Idrija (1770).

Prve zametke visokošolskega izobraževanja na področju zemljemerstva zasledimo na ljubljanskem liceju. Velik zagovornik in podpornik ustanovitve vseučilišča je bil Gabrijel Gruber, ki ga povezujemo z razvojem geodetske stroke pri nas.

The early higher education endeavours in land surveying are related to the Ljubljana Lyceum. Gabrijel Gruber, who can also take credit for the development of the surveying profession in Slovenia, was a keen advocate and supporter of the foundation of a university.

GABRIJEL GRUBER (1740–1805)

GABRIJEL GRUBER (1740–1805)



Gruberjev prekop na katastrskih načrtih iz leta 1824.

The Gruber Canal on cadastral plans from 1824.

Študij zemljemerstva je bil uveljavljen tudi v Ilirskih provincah, kar velja za začetek visokošolskega študija geodezije.

The study of land surveying organised in the Illyrian Provinces is considered the beginning of higher education in surveying.

Matrika ljubljanske centralne šole iz leta 1811: stran z vpisanimi študenti, njihovimi študijskimi predmeti in ocenami na stolici za inženirstvo in arhitekturo.

The 1811 matriculation book (register) of the Ljubljana Central School – a page with the enrolled students, their courses and grades at the Engineering and Architecture Chair.

Vse do ustanovitve univerze leta 1919 so se slovenski inženirski geometri lahko šolali samo na tujih tehničnih in višjih šolah. Edina izjema so bili katastrski zemljemerci in kartografi (maperji), za katere je deželni mapni arhiv v Ljubljani občasno organiziral tečaje.

Until the university's foundation in 1919, the Slovene surveying engineers could only gain their education abroad at technical and higher schools. The only exceptions were cadastral surveyors and cartographers (mappers), who could attend occasional courses organised by the provincial map archives in Ljubljana.

IVAN LAPANJA (1857–1945), zemljemerec in deželni poslanec, ki je leta 1885 v Trstu opravil izpit iz zemljemerstva.

IVAN LAPANJA (1857-1945), a land surveyor and member of the Provincial Assembly, who passed the land surveying exam in Trieste in 1885.

12.2 NOVODOBNO ŠOLSTVO (OD ZAČETKA 20. STOLETJA NAPREJ)

MODERN EDUCATION (FROM THE BEGINNING OF THE 20TH CENTURY)

V začetku 20. stoletja so se zemljemerstvo in z geodezijo povezani izobraževalni programi na Slovenskem izvajali na ravni obrtniških in strokovnih šol. Leta 1911 je bila deželna obrtna šola v Ljubljani, ki je zadnja desetletja 19. stoletja poučevala osnove zemljemerstva, preoblikovana v državno obrtno šolo z učno obsežnim tehničnim oddelkom.

Z ustanovitvijo Univerze v Ljubljani leta 1919 je zaživelo tudi poučevanje geodezije in zemljemerstva, ki se je z nekaj prekinitvami ohranilo vse do danes.

Ob ustanovitvi univerze so se na njej začeli šolati tudi geodeti, žal ne kot univerzitetno izobraženi strokovnjaki, ampak v okviru dvoletnega študija zemljemerstva.

Leto 1928 se je tečaj zemljemerstva razširil v štiriletni visokošolski študijski program kulturno-geodetske usmeritve.

At the beginning of the 20th century, surveying and related educational programmes in Slovenia were provided at the level of trade and vocational schools. In 1911, the provincial trade & crafts school in Ljubljana, which had taught the basics of surveying in the last decades of the 19th century, took the form of the State Trade & Crafts School with a comprehensive technical department.

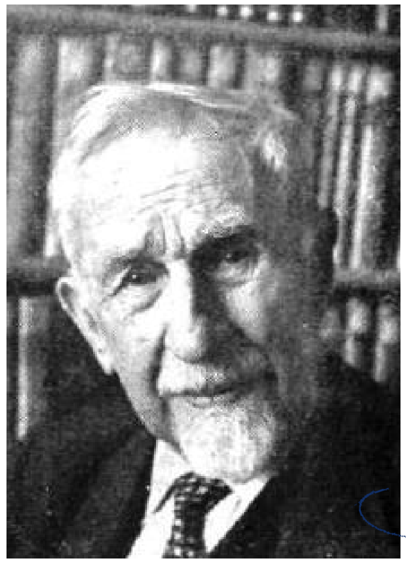
With the foundation of the University of Ljubljana in 1919, the teaching of geodesy and surveying also commenced and has continued, with some interruptions, to the present day.

Upon its establishment, the University only provided a two-year course in land surveying, thereby not enabling the students to become university-trained professionals.

In 1928, the course was extended into a four-year higher education programme in cultural-geodetic orientation.

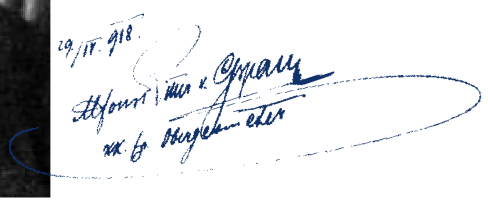
INŽ. LEO NOVAK (1894–1959), ustanovitelj zemljemerskega tečaja v okviru Univerze v Ljubljani.

ENG. LEO NOVAK (1894–1959) – a founder of the surveying course at the University of Ljubljana.



NADGEOMETER ALFONZ GSPAN (1878–1963), predavatelj v štiriletnem visokošolskem programu.

HEAD LAND SURVEYOR ALFONZ GSPAN (1878–1963) – a lecturer in a four-year higher education programme.



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V šolskem letu 1945/46 je bil organiziran devetsemestrski študijski program geodezije.

In the 1945/46 academic year, a nine-semester course in surveying and related studies was organised.

PROF. INŽ. IVAN ČUČEK (1911–1992), pionir fotogrametrije na Slovenskem in ustanovitelj Inštituta za geodezijo in fotogrametrijo.

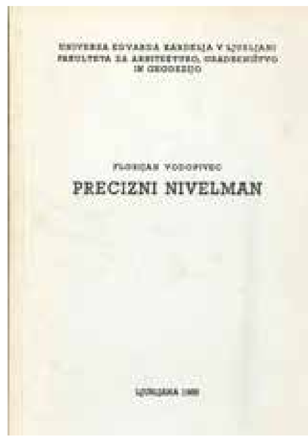
PROF. ENG. IVAN ČUČEK (1911–1992) – a pioneer in photogrammetry in Slovenia and founder of the Institute of Geodesy and Photogrammetry.

PROF. DR. FLORJAN VODOPIVEC (1934–2018), redni profesor, zaslužni profesor, več mandatov predstojnik Oddelka za geodezijo na Fakulteti za gradbeništvo in geodezijo Univerze v Ljubljani. Zaslužen za temeljito prenovo študija geodezije, kar je prispevalo k mednarodnemu ugledu fakultete.

PROF. FLORJAN VODOPIVEC, PHD (1934–2018), full professor, professor emeritus, head of the Department of Geodetic Engineering at the Faculty of Civil and Geodetic Engineering, University of Ljubljana for several terms. He is credited with a significant overhaul of the geodetic engineering study, which boasted the reputation of the Faculty internationally.

V nekaj več kot stoletni zgodovini se je na univerzi izšolalo več kot 2500 inženirjev, diplomiranih inženirjev in univerzitetnih diplomiranih inženirjev ter več kot sto akademsko izobraženih geodetov (magistrov in doktorjev znanosti).

In just over a century, the University has trained more than 2,500 engineers, graduates in engineering and university graduates in engineering, and more than a hundred Masters and PhDs in geodetic engineering.



Vzporedno z visokošolskim programom je potekalo tudi srednješolsko izobraževanje.

Leta 1920 so Državno obrtno šolo v Ljubljani preoblikovali v Tehnično srednjo šolo, v okviru katere je potekalo izobraževanje za potrebe gradbeništva (najprej na Aškerčevi 1, od leta 1968 pa v novem kompleksu za Bežigradom). V okviru njenih programov so se izobraževali tudi geodetski tehniki.

Zaradi velikih potreb države po geometrih je po drugi svetovni vojni (od 1946 do 1949) šolanje prve povojne generacije trajalo dve leti in pol. Leta 1979 je bil (za kratek čas) ustanovljen tudi dislocirani geodetski oddelek Srednje šole v Mariboru.

Secondary education also ran in parallel with the higher education programme.

In 1920, the State Craftsmanship School in Ljubljana took the form of the Technical Secondary School, which provided training for the needs of the construction industry (initially located at Aškerčeva Street, and since 1968, in a new complex in Bežigrad). These programmes provide training for the profession of surveying technician.

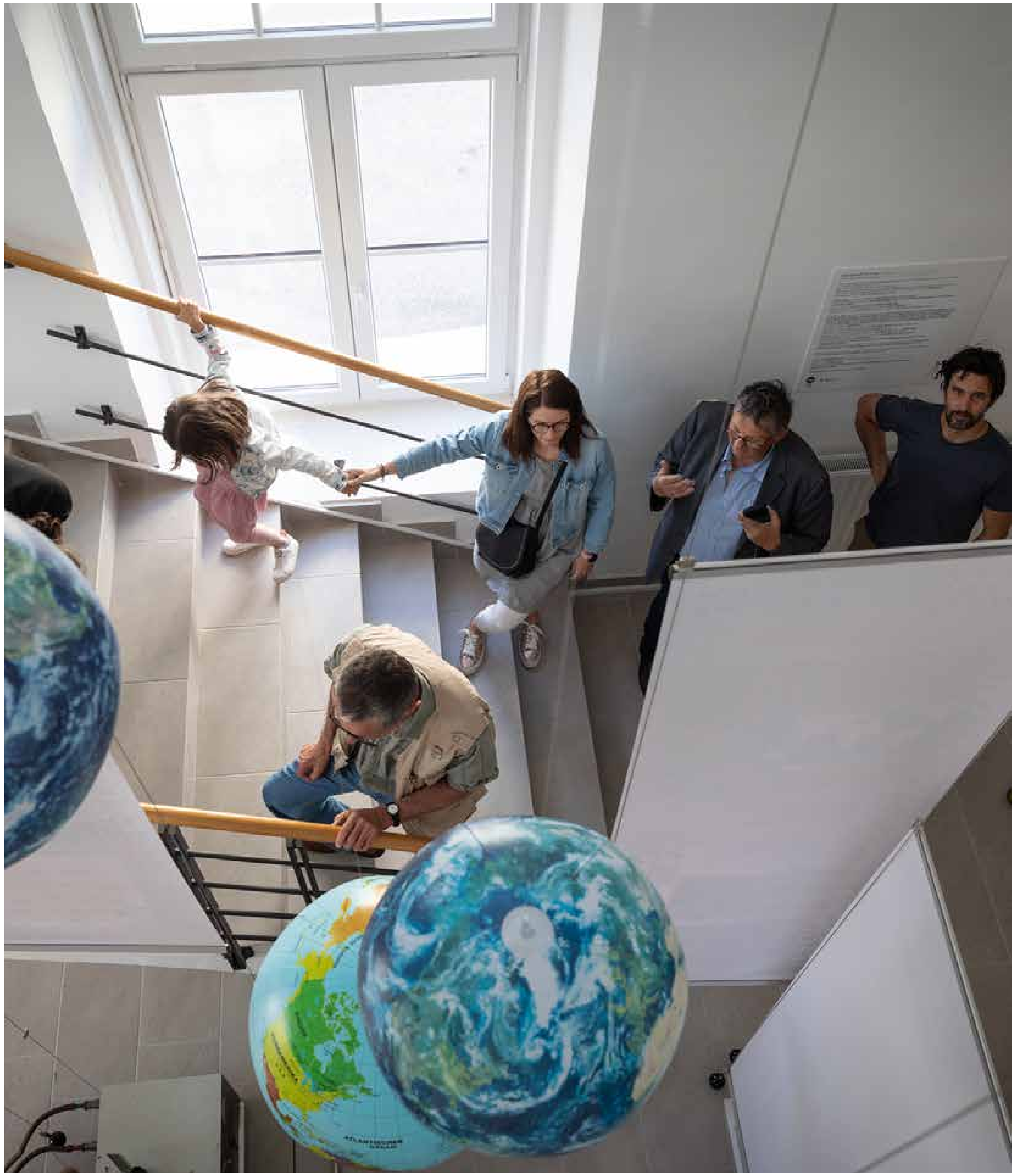
After the Second World War (from 1946 to 1949), the first post-war generation was trained for two and a half years due to the country's high demand for surveyors. In 1979, an off-site surveying department was established (temporarily) at the Secondary School in Maribor.

JOŽE POHAR (1905–2006), od leta 1950 do 1976 predavatelj na Srednji gradbeni šoli.

JOŽE POHAR (1905–2006) – a lecturer at the Secondary School of Civil Engineering from 1950 to 1976.

Gradbena tehnična šola v Ljubljani leta 1968, kamor se je izobraževanje za geodetskega tehnika preselilo z Aškerčeve ceste.

Construction Trade School in Ljubljana in 1968. The schooling of surveying technicians was previously held at Aškerčeva Street.



Razstava v Depojih državnih muzejev v Pivki, na dan odprtja razstave 18. maja 2022.

The exhibition in the Depots of national museums in Pivka on its opening day 18 May 2022.

13 KATALOG PREDMETOV

CATALOGUE OF THE EXHIBITS

Na razstavi v Depojih državnih muzejev v Pivki so bili na ogled muzejski predmeti iz Slovenske geodetske zbirke in iz Gozdarske zbirke Tehniškega muzeja Slovenije, iz zbirke instrumentov Geodetske uprave Republike Slovenije, iz Zbirke geodetskih instrumentov na Fakulteti za gradbeništvo in geodezijo UL ter iz zbirke Parka vojaške zgodovine Pivka. Največ je bilo teodolitov (instrumenti za merjenje kotov in dolžin) in nivelirjev (instrumenti za določanje višin). Na ogled je bil tudi originalni katastrski načrt franciscejskega katastra (star približno 200 let) in orodja za kartiranje (risanje) načrtov, računanje površin in risarski pribor iz obdobja pred več kot 150 leti.

The exhibition at the national museums' Depots in Pivka was featuring artefacts from the Slovene Geodetic Collection and from the Forestry Collection of the Technical Museum of Slovenia, the Instrument Collection of the Surveying and Mapping Authority of the Republic of Slovenia, the Collection of Geodetic Instruments at the Faculty of Civil and Geodetic Engineering, University of Ljubljana, and the collection of the Park of Military History Pivka. Theodolites (instruments for measuring horizontal and vertical angles) and levels (instruments for determining heights) accounted for a significant part of the exhibits. In addition, the visitors could also see the original Franciscean cadastre map (about 200 years old), instruments used in mapping and area calculation, and a drawing set dating back more than 150 years.

Teodolit Gebrüder Fromme, 1880 do 1890.
Hrani Tehniški muzej Slovenije, Gozdarska zbirka.
Inv. št. / Inv. no. 800:LJU;0000950

Gebrüder Fromme theodolite, 1880 to 1890.
Kept at the Technical Museum of Slovenia, Forestry Collection.

Teodolit Starke & Kammerer, okoli 1890.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008634

Starke & Kammerer theodolite, around 1890.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Teodolit Neuhöfer & Sohn, 1900 do 1910.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008633

Neuhöfer & Sohn theodolite, 1900 to 1910.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Teodolit tahimeter Ertel & Sohn, 1900 do 1910.
Hrani Fakulteta za gradbeništvo in geodezijo pri Univerzi v Ljubljani (UL FGG)
https://zbirka.fgg.uni-lj.si/instrument/11.

Ertel & Sohn tacheometer-theodolite, 1910 to 1920.
Kept at the Faculty of Civil and Geodetic Engineering, University of Ljubljana (UL FGG)
https://zbirka.fgg.uni-lj.si/instrument/11.

Tahimeter teodolit MOM 17 S, okoli 1940.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008638

MOM 17 S tacheometer-theodolite, about 1940.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Avtoredukcijski tahimeter Dahlta 010 B, 1980.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008608

Dahlta Dahlta 010 B self-reducing tacheometer, 1980.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Sekundni teodolit Kern DKM2-AE in elektronski razdaljemer Kern DM500, 1973.
Hrani Geodetska uprava Republike Slovenije.

Kern DKM2-AE second-order theodolite and Kern DM500 optical distance meter, 1973.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Elektronski teodolit Wild T1000 in distomat DI 1000, 1987.
Hrani Geodetska uprava Republike Slovenije.

Wild T1000 electronic theodolite and DI 1000 distomat, 1987.

Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

GNSS sprejemnik Trimble R8, 2008.
Hrani Geodetska uprava Republike Slovenije.

Trimble R8 GNSS receiver, 2008.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Kipregel Ertel & Sohn, okoli 1950.
Hrani Tehniški muzej Slovenije, Gozdarska zbirka.
Inv. št. / Inv. no. 800:LJU;0001662

Ertel & Sohn telescopic alidade, about 1950.
Kept at the Technical Museum of Slovenia, Forestry Collection.

Nivelir Rudolf & August Rost, okoli 1890.
Hrani Fakulteta za gradbeništvo in geodezijo pri Univerzi v Ljubljani (UL FGG),
https://zbirka.fgg.uni-lj.si/instrument/8

Rudolf & August Rost level, about 1900.
Kept at the Faculty of Civil and Geodetic Engineering, University of Ljubljana (UL FGG),
https://zbirka.fgg.uni-lj.si/instrument/8

Nivelir Otto Fennel, Kassel, okoli 1900.
Hrani Fakulteta za gradbeništvo in geodezijo pri Univerzi v Ljubljani (UL FGG),
https://zbirka.fgg.uni-lj.si/instrument/21

Otto Fennel & Söhne Kassel level, about 1900.
Kept at the Faculty of Civil and Geodetic Engineering, University of Ljubljana (UL FGG)
https://zbirka.fgg.uni-lj.si/instrument/21

Nivelir Carl Zeiss Koni 007, 1970.
Hrani Geodetska uprava Republike Slovenije.

Carl Zeiss Koni level 007, 1970.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Nivelir Leica NA3003, 1998.
Hrani Geodetska uprava Republike Slovenije.

Leica NA3003 level, 1998.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Krožni polarni transporter ali polarni koordinatograf Gebrüder Fromme, okoli 1890.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008574

Gebrüder Fromme circular protractor, about 1890.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Mali polarni planimeter Kern, 1870 do 1880.
Hrani Geodetska uprava Republike Slovenije.
Kern small polar planimeter, 1870 to 1880.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Trirobna prizma, okoli 1890.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008667
Triangular prism, about 1890.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Izrisovalnik izohips (»razsnolka«), okoli 1950.
Hrani Geodetska uprava Republike Slovenije.

Contour line sketching device, about 1950.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Jekleni merski trak s števnimi ali markirnimi ključi se je uporabljal že od leta 1880 naprej.
Hrani Geodetska uprava Republike Slovenije.
Steel measuring tape with marking pins, about 1880.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Vojaški instrument Nadelverb R. K. 12m beh 1349 KF, 1930 do 1935.
Hrani Park vojaške zgodovine v Pivki.

Nadelverb R. K. 12m beh 1349 KF German bunker construction theodolite, 1930 to 1935.
Kept at the Park of Military History Pivka.

Načrt Franciscejskega katastra, 1824.
Franciscean cadastre map, 1824.

Polarni koordinatograf, okoli 1900.
Hrani Geodetska uprava Republike Slovenije.

Polar coordinatograph, about 1900.
Kept at the Surveying and Mapping Authority of the Republic of Slovenia.

Logaritmično računalo, okoli 1950.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 00:LJU;0008665

Slide rule, 1950.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Nitni planimeter Adolf Fromme ali planimetrska harfa, okoli 1880.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008446

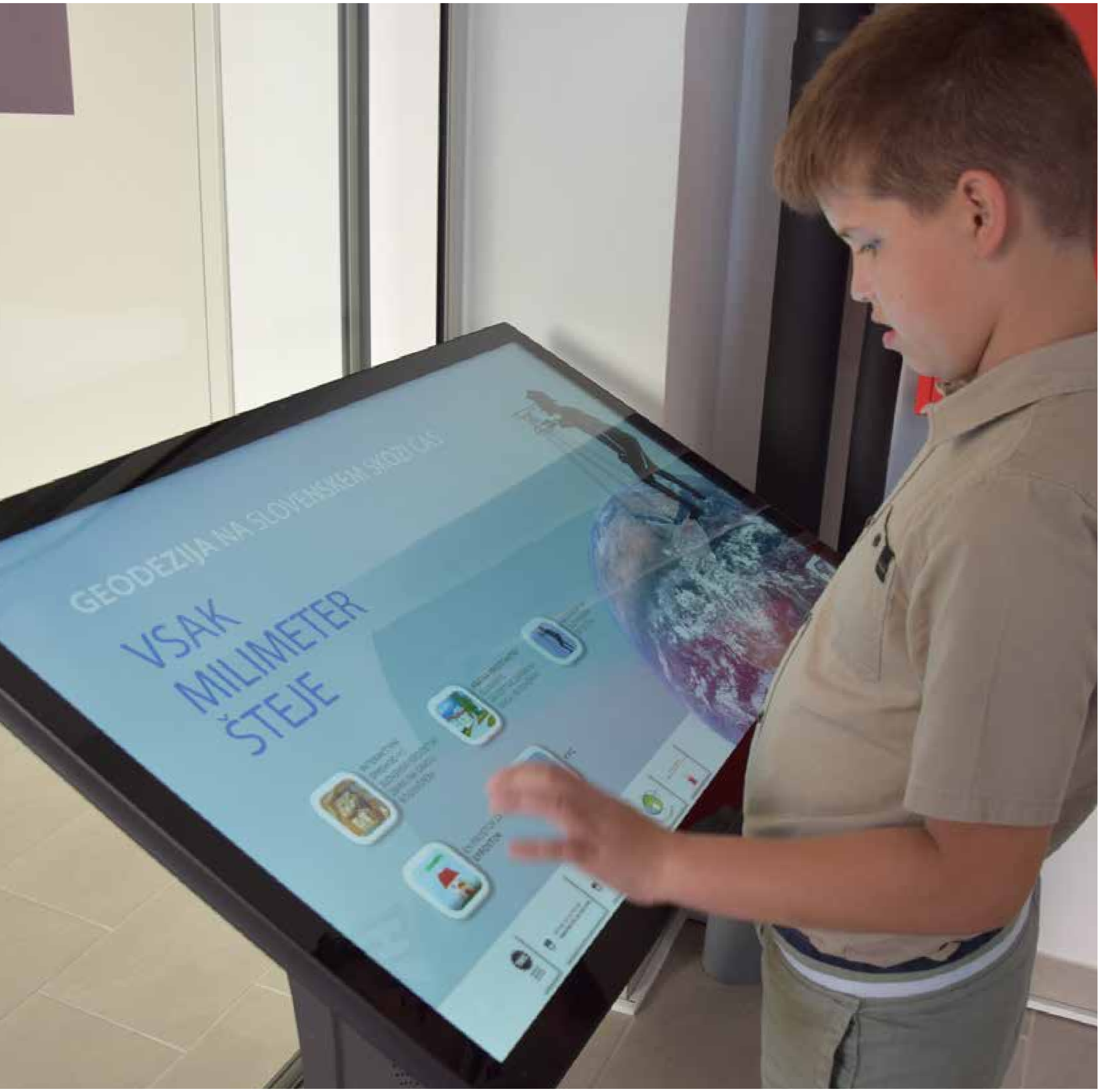
Adolf Fromme thread planimeter also known as harp planimeter, about 1880.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Mehanski računski stroj, 1955.
Hrani Tehniški muzej Slovenije, Slovenska geodetska zbirka.
Inv. št. / Inv. no. 800:LJU;0008666

Mechanical calculator, 1955.
Kept at the Technical Museum of Slovenia, Slovene Geodetic Collection.

Razstava v Depojih državnih muzejev v Pivki 2022, namenjena tudi mlajšim obiskovalcem.

Exhibition in the Depot of State Museums in Pivka 2022, also intended for younger visitors.



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VSAK MILIMETER ŠTEJE: GEODEZIJA NA SLOVENSKEM SKOZI ČAS /
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