54. Geodetski dan

Geodezija brez meja

Povzetki vabljenih predavanj

Ljubljana, 18. in 19. november 2026

Kolofon

Urednica:	doc. dr. Mihaela Triglav Čekada
Uredniški odbor:	doc. dr. Mihaela Triglav Čekada
	Katja Tič
	Matej Plešnar
	mag. Toni Levičnik
	dr. Primož Mavsar
	mag. Erna Flogie Dolinar
	Tomaž Petek
	Kristina Murovec
	Nejc Krašovec
	Aljaž Peklaj
	Alen Šraj
	doc. dr. Dušan Petrovič
	prof. dr. Anka Lisec
	doc. dr. Marjan Čeh
	Boštjan Trobiš
Oblikovanje:	Marina Lovrić
Izdala:	Zveza geodetov Slovenije in Ljubljansko geodetsko društvo

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID 294306563
ISBN 978-961-93656-7-0 (Zveza geodetov Slovenije, PDF)

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Program dogodka

Sreda, 18. 11. 2026 / Wednesday, 18 November 2026

8:00	**Registracija / Registration**
9:00	**Uvodni pozdravi / Welcome speeches** **VABLJENA PLENARNA PREDAVANJA / INVITED PLENARY LECTURES**

Uvodni pozdravi predsednika Zveze geodetov Slovenije, predstavnika Ministrstva za okolje in prostor, v. d. generalne direktorice Geodetske uprave Republike Slovenije in predsednice Ljubljanskega geodetskega društva / *Welcome speeches President of the Association of Surveyors of Slovenia, a representative of the Ministry of the Environment and Spatial Planning, the Acting Director-General of the Surveying and Mapping Authority of the Republic of Slovenia, and the President of the Ljubljana Surveying Society*

Introduction to the CLMS National Collaboration Programme and relevant CLMS use cases / *Uvod v nacionalni program sodelovanja CLMS in primeri njegove uporabe*
Laura-Ainhoa Prischl, European Environment Agency, Kopenhagen, Danska

Naši geodeti po svetu / *Our surveyors around the world*
Geodezija v Keniji / *Geodesy in Kenya*
Primož Kovačič, Spatial Collective, Nairobi, Kenija

Geodezija v Kanadi / *Geodesy in Canada*
Žiga Zadnik, Ledcor, Toronto, Kanada

Razprava / Discussion

10:30	**Odmor / Coffee break**
11:15	**PREDAVANJA I / LECTURES I** **Vesoljske tehnologije v geodeziji / Space Technologies in Geodesy** *Moderator: dr. Alen Mangafić*

Zlata doba opazovanja Zemlje – kako vsakodnevni visokoločljivi posnetki spreminjajo razumevanje prostora / *The golden age of Earth observation – How daily high-resolution images are changing our understanding of space*
prof. dr. Krištof Oštir, UL FGG

Dosežki slovenskega satelita NEMO-HD / *Achievements of the Slovenian satellite NEMO-HD*
prof. dr. Tomaž Rodič, VESOLJE-SI

Motenje signalov GNSS: do kolikšne mere se lahko še zanašamo na GNSS? / *GNSS signal interference: To what extent can we still rely on GNSS?*
izr. prof. dr. Polona Pavlovčič Prešeren, UL FGG

Zanesljiv GeoAI temelji na semantični infrastrukturi / *Trusted GeoAI has its foundation in semantic infrastructure*
Gregor Završnik, doc. dr. Marjan Čeh in Vid Primožič, UL FGG, Geoarh in Flycom Technologies

Razprava / Discussion

12:30	**Kosilo / Lunch**

	Predstavitev razstavljavcev / Exhibitor Presentations
14:00	**PREDAVANJA II / LECTURES II** **Prostorski podatki kot infrastruktura prihodnosti /** **Spatial Data as the Infrastructure of the Future** *Moderator: doc. dr. Dejan Grigillo*
	Zemlja brez meja: geoprostorski digitalni dvojček Slovenije – VAIKARDD / *Earth without borders: Slovenia's geospatial digital twin – VAIKARDD* ***mag. Erna Flogie Dolinar, Andraž Muhič in prof. dr. Anka Lisec, Geodetska uprava Republike Slovenije in UL FGG***
	Geo Slovenija: več kot infrastruktura / *Geo Slovenia: Beyond infrastructure* ***Matjaž Grilc in Tomaž Petek, Geodetska uprava Republike Slovenije***
	Aerolasersko skeniranje v arheologiji brez meja / *Airborne laser scanning in archaeology without borders* ***izr. prof. dr. Žiga Kokalj, Inštitut za antropološke in prostorske študije ZRC SAZU***
	Razprava / Discussion
15:00 – 15:20	**Krajši odmor / Short break**
	Zemlja iz vesolja: napredni pristopi k spremljanju prostora s satelitskimi podatki / *Earth from space: Advanced approaches for monitoring Earth's surface using satellite data* ***dr. Andreja Švab Lenarčič, Geodetska uprava Republike Slovenije***
	Praktična implementacija ocenjevanja kakovosti po ISO 19157 v državnih podatkovnih zbirkah in njen pomen pri avtomatizirani zaznavi prostorskih podatkov / *Practical implementation of ISO 19157 quality evaluation in national spatial datasets and its significance for the automated detection of geospatial data* ***Primož Kete, dr. Andreja Švab Lenarčič in Katja Šušteršič, Geodetski inštitut Slovenije, Geodetska uprava Republike Slovenije in Flycom Technologies***
	Geodetski podatki kot podpora multimodalni mobilnosti oseb z različnimi invalidnostmi / *Geodetic data as support for the multimodal mobility of persons with various disabilities* ***mag. Roman Rener, Marina Lovrić in Jani Demšar, Geodetski inštitut Slovenije***
	Razprava / Discussion
18:00	**Slavnostna akademija, posvečena izidu 70. letnika Geodetskega vestnika / Event celebrating the release of the 70th volume of the Geodetski vestnik**

Četrtek, 19. 11. 2026 / Thursday, 19 November 2026

9:00	**PREDAVANJA III / LECTURES III** **Zemljiška politika / Land Policy** *Moderator: mag. Dušan Mitrović*
	Kataster nepremičnin: izvedba in izzivi** / Real estate cadastre - Implementation and challenges* ***mag. Ema Pogorelčnik, Marko Rotar, Jaka Urbanc, Andrej Hudoklin in Dominik Zupan, Geodetska uprava Republike Slovenije
	Evidenca stavbnih zemljišč v praksi: podatkovna podlaga za izvajanje zemljiške politike** / The Register of building land in practice: A data basis for implementing land policy* ***Ajda Kafol Stojanović, mag. Matija Kralj in Petra Kurnik, Geodetski inštitut Slovenije in Ministrstvo za okolje in prostor
	Prenova metodologij ocenjevanja vrednosti nepremičnin v javno korist** / Enhancement of real estate valuation methodologies for public sector acquisitions* ***Valentina Brečko Čebela, Geodetska uprava Republike Slovenije
	Analiza stanja lastništva in vrednosti nepremičnin v lasti pravnih oseb** / Analysis of the ownership status and value of real estate owned by legal entities* ***Kristina Perko in Maja Ristić, Geodetska uprava Republike Slovenije
	Odkup zemljišč in ureditev služnosti za GJI** / Land acquisition and establishment of servitudes for public infrastructure* ***Toni Levičnik, Plinovodi, d.o.o.
	Razprava / Discussion
10:30	**Odmor / Coffee break**
11:15	**PREDAVANJA IV / LECTURES IV** **OKROGLA MIZA / Roundtable**
	Analiza upravne urejenosti objektov** / Analysis of the administrative compliance of infrastructure* ***Nejc Krašovec in Aljaž Peklaj, GIZ-GI
	Okrogla miza: Prihodnost zemljiške politike / *Roundtable: The future of land policy* ***Moderator okrogle mize: mag. Tomaž Černe, IGEA***
13:00	**Zaključek s pogostitvijo in druženjem / Conclusion and social event**

Nagovor

Letošnji 54. Geodetski dan bo potekal 18. in 19. novembra 2026 na Gospodarskem razstavišču Ljubljana pod naslovom Geodezija brez meja. Dogodek želi združiti stroko, gospodarstvo in širšo družbo, kjer se prepletajo znanje, inovacije in odgovornost do prostora, v katerem živimo. Želimo odpreti nove razprave, predstaviti zanimive zgodbe in okrepiti zavedanje o pomenu geodetske stroke v sodobni družbi. Verjamemo, da lahko skupaj premikamo meje – strokovne, tehnološke in miselne.

Vabljena plenarna predavanja bodo predstavila aktivnosti Evropske okoljske agencije na področju storitev Copernicus Land Monitoring Service (CLMS), ki so ključne za evropske, državne in lokalne odločevalce, saj podpirajo področja, kot so okoljsko upravljanje, prostorsko načrtovanje in prilagajanje na podnebne spremembe. V nadaljevanju bomo slišali zanimivi zgodbi geodetov, ki delata v Keniji in Kanadi.

V sklopu »*Vesoljske tehnologije v geodeziji*« bodo predstavljeni najnovejši trendi na področju opazovanja Zemlje, dosežki slovenskih satelitskih misij ter aktualni izzivi meritev GNSS v času vse pogostejših motenj signalov. V sklopu »*Prostorski podatki kot infrastruktura prihodnosti*« bodo predstavljeni zanimivi praktični primeri možnosti uporabe raznoterih prostorskih podatkov za podporo raziskavam v arheologiji ter osebam z različnimi invalidnostmi. Predstavljene bodo tudi možnosti, ki jih omogoča Geodetska uprava Republike Slovenije preko skupnih pobud za dostop do satelitskih podatkov, sodelovanja v skupnosti GEO Slovenija ter načrtov glede vzpostavitve digitalnih dvojčkov Slovenije. Dan se bo sklenil s slavnostno akademijo, ki bo posvečena izidu 70. letnika Geodetskega vestnika.

Drugi dan je namenjen zemljiški politiki ter njeni prihodnosti. Pričeli bomo s sklopom o novostih na področjih katastra nepremičnin, evidence stavbnih zemljišč in prenove metodologij ocenjevanja vrednosti nepremičnin. Nadaljevali bomo s predstavitvama analize lastništva nepremičnin v lasti pravnih oseb ter s primeri urejanja služnosti pri umeščanju gospodarske javne infrastrukture v prostor. Zaključek bo pripadel razpravi na okrogli mizi »*Prihodnost zemljiške politike*«, ki odpira izjemno aktualne teme.

doc. dr. Mihaela Triglav Čekada
Predsednica programskega odbora

Katja Tič
Predsednica organizacijskega odbora

mag. Toni Levičnik
Predsednik Zveze geodetov Slovenije

Introduction

This year's 54th Geodetic Day will take place on 18 and 19 November 2026 at the Ljubljana Exhibition and Convention Centre under the title "Geodesy without borders". The event aims to bring together the professional community, the business sector and wider society and create a setting in which knowledge, innovation and responsibility for the physical environment intertwine. We wish to open up new discussions, present interesting stories and raise awareness of the importance of the geodetic profession in modern society. We believe that together we can push boundaries – professional, technological and intellectual.

The invited plenary lectures will present the European Environment Agency's activities in the field of the Copernicus Land Monitoring Service (CLMS), which are crucial for European, national and local decision-makers as they support areas such as environmental management, spatial planning and adaptation to climate change. We will then hear fascinating stories from surveyors working in Kenya and Canada.

The first session entitled "*Space technologies in geodesy*" will present the latest trends in Earth observation, the achievements of Slovenian satellite missions and the current challenges facing GNSS measurements in the face of increasingly frequent signal disruptions. The session "*Spatial data as the infrastructure of the future*" will present interesting practical examples of how diverse spatial data can be used to support archaeological research and assist people with various disabilities. The opportunities provided by the Surveying and Mapping Authority of the Republic of Slovenia will also be presented, including joint initiatives for access to satellite data, participation in the GEO Slovenia community and plans for the creation of digital twins of Slovenia. The day will conclude with a formal ceremony dedicated to the publication of the 70th volume of the Slovenian geodetic scientific journal Geodetski vestnik.

The second day is devoted to land policy and its future. We will begin with a series of presentations on developments in the areas of the real estate cadastre, the register of built land and the overhaul of property valuation methodologies. We will continue with presentations analysing property ownership by legal entities and with case studies on the regulation of easements in the spatial planning of public utility infrastructure. The event will conclude with a round-table discussion entitled "*The future of land policy*", which will address highly relevant issues.

Assist. prof. dr. Mihaela Triglav Čekada
Chair of the programme committee

Katja Tič
Chair of the local organising committee

mag. Toni Levičnik
President of the Association of Surveyors of Slovenia

Povzetki

Uvod v nacionalni program sodelovanja CLMS in primeri uporabe CLMS

Introduction to the CLMS National Collaboration Programme and relevant CLMS use cases

Laura-Ainhoa Prischl

SUMMARY

The Copernicus Land Monitoring Service (CLMS), one of the six services of the European Union Space Programme, provides harmonised and consistent land monitoring information across Europe. Through a comprehensive portfolio of land cover, land use, biophysical and environmental products, CLMS supports decision-making, environmental monitoring, spatial planning and policy implementation at European, national and local levels.

To strengthen the relevance and uptake of CLMS across participating countries, the CLMS National Collaboration Programme (NCP) was established as a structured framework for engagement between CLMS and national stakeholders. The programme aims to increase the use of CLMS products at national and subnational levels, validate their quality, identify user needs and ensure that existing and future products are fit for purpose. Through stakeholder engagement, technical collaboration and participation in national events and networks, the NCP helps bridge the gap between European land monitoring services and national implementation needs.

This presentation provides an introduction to both the CLMS portfolio and the National Collaboration Programme, highlighting how collaboration with national authorities, research institutions and other stakeholders contributes to the continuous evolution of the service. Particular attention will be given to experiences from Slovenia and opportunities for integrating CLMS products into environmental monitoring and spatial data workflows.

Using examples from the Ljubljana region, we demonstrate how different CLMS products can support practical applications related to urban development, land cover monitoring and environmental assessment. By comparing products with varying spatial resolutions, thematic content and update frequencies, we illustrate how selecting the appropriate dataset depends on the policy question or monitoring objective being addressed. The examples showcase both the strengths and limitations of current products and provide insights into how CLMS data can complement national datasets and support evidence-based decision-making.

The presentation aims to encourage greater awareness and uptake of CLMS products while demonstrating how European Earth Observation services can support national and local challenges in environmental management, spatial planning and sustainable development.

KEY WORDS: Copernicus Land Monitoring Service, National Collaboration Programme, policy applications, monitoring, Europe, Slovenia

POVZETEK

Storitve programa Copernicus za spremljanje kopnega (CLMS) je ena od šestih storitev vesoljskega programa Evropske unije. Zagotavlja usklajene in dosledne informacije o spremljanju kopnega po vsej Evropi. S celovito ponudbo produktov na področju pokritosti tal, rabe tal, biofizikalnih in okoljskih podatkov CLMS podpira sprejemanje odločitev, spremljanje okolja, prostorsko načrtovanje ter izvajanje politik na evropski, nacionalni in lokalni ravni.

Da bi okrepili pomembnost in uporabo CLMS v sodelujočih državah, je bil ustanovljen Nacionalni program sodelovanja CLMS (NCP) kot strukturiran okvir za sodelovanje med CLMS in nacionalnimi zainteresiranimi stranmi. Cilj programa je povečati uporabo produktov CLMS na nacionalni in regionalni ravni, potrditi njihovo kakovost, ugotoviti potrebe uporabnikov ter zagotoviti, da so obstoječi in prihodnji produkti primerni za predvideno uporabo. Prek vključevanja zainteresiranih strani, tehničnega sodelovanja ter udeležbe na nacionalnih dogodkih in v mrežah NCP pomaga premostiti vrzel med evropskimi storitvami spremljanja kopnega in nacionalnimi potrebami po izvajanju.

Ta predstavitev ponuja uvod v portfelj CLMS in v Nacionalni program sodelovanja ter poudarja, kako sodelovanje z nacionalnimi organi, raziskovalnimi institucijami in drugimi zainteresiranimi stranmi prispeva k neprestanemu razvoju storitve. Posebna pozornost bo namenjena izkušnjam iz Slovenije in možnostim za vključitev produktov CLMS v delovne tokove okoljskega spremljanja in prostorskih podatkov.

Na primerih iz ljubljanske regije bomo prikazali, kako lahko različni produkti CLMS podpirajo praktične načine uporabe, povezane z urbanističnim razvojem, spremljanjem pokritosti tal in okoljsko oceno. S primerjavo produktov različnih prostorskih ločljivosti, različno tematiko in pogostostjo posodabljanja bomo ponazorili, kako je izbira ustreznega niza podatkov odvisna od obravnavanega vprašanja javnih politik ali cilja spremljanja. S primeri bomo prikazali tako prednosti kot omejitve sedanjih produktov ter ponudili vpogled v to, kako lahko podatki CLMS dopolnjujejo nacionalne podatkovne nize in podpirajo odločanje, temelječe na dokazih.

S predstavitvijo si bomo prizadevali spodbuditi večjo ozaveščenost in uporabo produktov CLMS, hkrati pa prikazati, kako lahko evropske storitve opazovanja Zemlje podpirajo reševanje nacionalnih in lokalnih izzivov na področju okoljskega upravljanja, prostorskega načrtovanja in trajnostnega razvoja.

KLJUČNE BESEDE: Storitev programa Copernicus za spremljanje kopnega, nacionalni program sodelovanja, uporaba za podporo javnim politikam, monitoring, Evropa, Slovenija

Laura-Ainhoa Prischl, M.Sc.
European Environment Agency, Kongens Nytorv 6, 1050 Copenhagen, Denmark
e-naslov: laura.prischl@eea.europa.eu

Geodezija v Keniji: Digitalna javna dela, od lokalnega sodelovanja do prostorskih podatkov

Geodesy in Kenya: Digital public works, turning local participation into geospatial data

mag. Primož Kovačič

POVZETEK

Kako lahko stotine ljudi prispeva k proizvodnji zanesljivih prostorskih podatkov, tudi brez predhodnih poklicnih izkušenj?

Spatial Collective je to vprašanje raziskal z digitalnimi javnimi deli (DJD), obsežnim projektom v Keniji, ki je združil zaposlovanje mladih, prostorsko tehnologijo in proizvodnjo podatkov skozi kolektivno akcijo. Udeleženci so prispevali h kartiranju stavb, infrastrukture in storitev, zajemanju zemeljskih posnetkov na ravni ulic, izvajanju hišnih raziskav in interpretaciji prostorskih informacij z digitalnimi mikro-nalogami.

Projekt je pokazal, da je mogoče kompleksno proizvodnjo prostorskih in statističnih podatkov razdeliti na dostopne naloge in jo porazdeliti med veliko število udeležencev. Kakovost zajetih podatkov je bila podprta s sprotnim usposabljanjem, avtomatiziranimi kontrolami, strokovnim pregledom in ponavljajočimi se neodvisnimi prispevki, pri katerih je ujemanje med več neodvisnimi opazovanji povečalo zaupanje v podatke.

Projekt DJD ponuja praktičen primer, kako lahko organizacije razširijo proizvodnjo podatkov onkraj tradicionalnih poklicnih delovnih procesov. Z združevanjem tehnologije, lokalnega znanja, množičnega sodelovanja in zagotavljanja kakovosti je Spatial Collective predstavil nov model za proizvodnjo podrobnih prostorskih podatkov, hkrati pa ustvaril priložnosti za ljudi, da sodelujejo v digitalnem gospodarstvu.

KLJUČNE BESEDE: digitalna javna dela, prostorski podatki, množično sodelovanje, lokalno znanje, Kenija

SUMMARY

How can hundreds of people contribute to the production of reliable geospatial data, even without previous professional experience?

Spatial Collective explored this question through Digital Public Works (DPW), a large-scale implementation in Kenya that combined youth employment, geospatial technology and community-based data production. Participants contributed to mapping buildings, infrastructure and services, capturing street-level imagery, conducting household surveys and interpreting spatial information through digital microtasks.

The project demonstrated that complex data production can be divided into accessible tasks and distributed among large numbers of participants. Quality was supported through training, automated controls, expert review and repeated independent contributions. Agreement between multiple observations increased confidence in the resulting information.

DPW provides a practical example of how geospatial organisations can extend data production beyond traditional professional workflows. By combining technology, local knowledge, distributed participation and quality assurance, Spatial Collective demonstrated

a model for producing detailed spatial information while simultaneously creating opportunities for people to participate in the digital economy.

KEY WORDS: digital public works, geospatial data, crowdsourcing, local knowledge, Kenya

mag. Primož Kovačič, mag. strat. pol. kom. (George Washington University), univ. dipl. geod.
Spatial Collective Limited, Ngong Road Suite 309, Nairobi, Kenya
e-naslov: primoz@spatialcollective.com

Geodezija v Kanadi

Geodesy in Canada

Žiga Zadnik

POVZETEK

Pred odhodom v Kanado pred malo več kot desetletjem si nisem niti približno predstavljal, kaj pričakovati in s kakšnimi izzivi se bo treba spopasti v prvih mesecih. Dejstvo je, da sama sprememba okolja, države in (v mojem primeru) kontinenta sama po sebi predstavlja precej velik izziv. Ko dodamo še dokaj specifično službo oz. poklic, izzivi postanejo še toliko bolj zanimivi.

Prvi stiki z geodezijo v Kanadi so se začeli zgolj 14 dni po končanem zagovoru diplomskega dela na UL FGG ter le tri dni po pristanku na letališču v Torontu. Časa za prilagajanje torej ni bilo veliko. Delovnih izkušenj se med časom študija ni nabralo na pretek. Mogoče za kakšno leto, pa še to zgolj v katastru in zgolj v Sloveniji.

Moja prva zaposlitev v Kanadi je bila v vlogi geodeta na projektu podzemne železnice. Velik in zahteven inženirski projekt, kjer je prostora za napake malo, tolerance pa so majhne. Poleg okolja in jezika je svojevrsten izziv predstavljala še organizacija dela ter poznavanje metričnega in imperialnega sistema. Ne glede na to, da je Kanada z uporabo metričnega sistema uradno pričela v zgodnjih sedemdesetih letih prejšnjega stoletja, se vpliva ameriškega sistema ni popolnoma otresla in se ga tudi ne more. Hitro je postalo jasno, da bo potrebno osvojiti vsaj osnove imperialnega sistema za potrebe dela in tudi vsakodnevnega življenja v Kanadi.

Sama organizacija dela v geodeziji je malenkost drugačna, kot sem jo sam izkusil v Sloveniji. V Kanadi je večinoma ločeno delo v pisarni od dela na terenu. To pomeni, da delo, ki bi ga v Sloveniji opravljal sam (terensko delo ter kasneje delo v pisarni), v Kanadi opravljata dva zaposlena. Jaz sem seveda začel z delom na terenu z ekipo štirih geodetov. Zanimivo je, da v Kanadi ni posebne šole oz. izobraževalnega programa, namenjenega geodeziji. Vsi geodeti so priučeni. Nekateri programi na srednjih šolah ali univerzah imajo možnost izbire predmeta geodezije (samo en semester), kjer se spoznajo z uporabo instrumentov in nekaj osnovami. Vse ostalo znanje si je potrebno pridobiti v službi.

Po končanem projektu na podzemni železnici sem delo nadaljeval na zemljiškem katastru. Kataster v Kanadi se zelo razlikuje od katastra v Sloveniji. Največja razlika je predvsem v načinu in obsegu dela ter obliki posameznih parcel. Z gotovostjo si upam trditi, da je 80 % vseh parcel v Torontu in širši okolici pravokotnih, kar pomeni, da imajo samo 4 mejnike. To precej olajša delo ter same postopke. Sam postopek ureditve meje se začne z zbiranjem dokumentacije o parceli približno dva tedna pred samo izmero. Dokumentacijo hranijo občinski uradi oz. uradi, ki jih upravlja provinca (neke vrste urad za zemljiški kataster). Dokumentacija vsebuje večino znanih podatkov o parceli: od prve geodetske izmere (zgodnje 19. stoletje) do najnovejše izmere, ki je bila evidentirana v evidencah katastra (ni pa nujno, da je evidentirana tudi najnovejša oz. zadnja izmera). Zanimivo je, da imajo načrti, ki so starejši, večkrat večjo veljavo kot načrti, izdelani pred nekaj leti oz. desetletji. Hierarhija je pogosto odvisna od evidence oz. tipa mejnika. Pogosto novejše načrte, ki niso del evidence, naročimo oz. kupimo od lokalnih geodetskih podjetij.

Samo terensko delo je precej preprosto. Delo se začne z iskanjem obstoječih mejnikov. V nasprotju s Slovenijo mejniki tukaj nimajo znanih koordinat. Mejnike se v začetni fazi locira z

detektorjem kovin. Novejši mejniki so 2,5 cm × 2,5 cm (1 palec × 1 palec) debele kovinske palice, dolge med 60 in 120 cm (2 do 4 čevlje), ki so približno 10-20 cm pod površjem. Starejši mejniki imajo lahko tudi obliko votlih kovinskih cevi premera 2,5 cm (1 palec). Če mejnikov ne najdemo, jih pričnemo iskati na sosednji parceli. V praksi lahko poiščemo mejnike tudi več deset metrov stran od naročnika na isti strani ulice, saj so vsi mejniki praviloma na isti liniji z istim odmikom od sredine cestišča. Ta razdalja je odvisna od širine ceste in znaša od 33 do približno 66 čevljev od sredine vozišča. Te mejnike kasneje uporabimo za bolj natančno orientiranje parcele v prostoru (rotacija), preden se opravi končna zakoličba. Med postopkom lociranja mejnih točk mejnike, ki smo jih našli, izmerimo v lokalnem ali državnem koordinatnem sistemu. Poleg mejnih točk se izmeri še sam tloris naročnikove nepremičnine (temeljev) ter tlorisa nepremičnin neposredno ob naročnikovi meji, zgolj levo in desno.

Med osnovno geodetsko izmero redko izmerimo več kot 30 točk. Potem se delo preseli v pisarno. Delo v pisarni prevzame risar (ang. drafter), ki izmerjene točke primerja z dokumentacijo, prejeto od občinskega urada ali dokumentacijo, ki smo jo pridobili od lokalnih geodetskih podjetij. Izvede kontrole dolžin med posameznimi mejniki, kontrolo kotov med posameznimi stranicami ter odmike temeljev obstoječega objekta od meje. Če vseh mejnikov na terenu nismo našli, lokacije novih mejnikov izračuna na podlagi dolžin in kotov med najdenimi in izmerjenimi mejniki na terenu. Po končanih izračunih v pisarni podatke posreduje terenski ekipi, ki ponovno izvede končno zakoličbo. Med samim postopkom končne zakoličbe vse nove mejnike izmerimo za lastno evidenco. Med postopkom ureditve meje nihče od vpletenih (naročnik in sosedje) ni prisoten pri zakoličbi. Delo se v večini primerov opravi v dveh delovnih dneh. Prvi dan (4–6 ur) je potreben za lociranje in izmero obstoječih mejnikov. Za končno zakoličbo (približno 1 teden kasneje) je potrebna še približno ura ali dve dela na terenu. Skupaj večina parcelacij ne traja več kot en delovni dan. Nova parcelacija ter lokacije novih mejnikov, ki se potem z elaboratom parcelacije pošljejo naročniku ter občinskemu uradu, zanimivo, ne vsebuje koordinat, ampak samo nove odmike ter kote, če so se ti med postopkom nove parcelacije spremenili.

Delo na katastru je meni osebno hitro postalo monotono, bilo pa je relativno nenaporno, razen pozimi, ko se temperature spustijo do −30 °C in iskanje mejnikov ni nič kaj prijetna naloga. Po slabem letu dni dela na katastru sem nove izzive našel v gradnji stolpnic v centru Toronta in se kasneje vrnil na železnice, kjer delo opravljam še danes.

KLJUČNE BESEDE: zemljišče, zemljiški kataster, Kanada

SUMMARY

Before moving to Canada a little over a decade ago, I had little idea what to expect and what challenges I would face during my first few months. The fact is that changing one's environment, country and even continent (as in my case) is a significant challenge in itself. When you add a highly specialised profession such as surveying, those challenges become even more interesting.

My first encounter with surveying in Canada began just 14 days after graduating from the Faculty of Civil and Geodetic Engineering at the University of Ljubljana and only three days after landing at Toronto Pearson Airport. There was not much time to adapt. During my studies, I had accumulated only limited work experience, perhaps equivalent to about one year, and that was exclusively in cadastral surveying and only in Slovenia.

My first job in Canada was as a surveyor on a subway construction project. It was a large and demanding engineering project where there was very little room for error and tolerances were tight. Besides adapting to a new environment and language, another unique challenge was the organisation of work and the use of both the metric and imperial measurement systems. Although Canada officially began adopting the metric system in the early 1970s, it has never completely freed itself from the influence of the American system. It quickly became clear that I would need to learn at least the basics of the imperial system for both work and everyday life in Canada.

The organisation of surveying work is somewhat different from what I experienced in Slovenia. In Canada, office work and field work are generally separated. This means that tasks which I would have completed on my own in Slovenia, including both fieldwork and office processing, are typically performed by two different employees in Canada. Naturally, I started out in the field as part of a team of four surveyors.

Interestingly, Canada does not have a dedicated educational programme specifically for surveying. Most surveyors learn the profession on the job. Some college and university programmes offer a single-semester surveying course, where students become familiar with survey instruments and basic concepts, but all other knowledge must be acquired through practical experience.

After completing the subway project, I continued my career in land cadastral surveying. The cadastre in Canada differs significantly from its counterpart in Slovenia. The biggest differences relate to the methods, scope of work and the shape of individual parcels. I can confidently say that approximately 80% of all parcels in Toronto and the surrounding area are rectangular, meaning they have only four boundary markers. This significantly simplifies both the work and the procedures involved.

The boundary survey process begins with gathering property documentation approximately two weeks before the field survey itself. These records are maintained by municipal offices or provincial agencies, which function somewhat like a land cadastre office. The documentation contains most known information about the property, ranging from the first survey conducted in the early nineteenth century to more recent surveys recorded in official records, although it is not necessarily that the most recent surveys are included in this record.

Interestingly, older plans often carry greater legal weight than plans prepared only a few years or decades ago. The hierarchy of evidence often depends on the type of record or boundary marks involved. If boundary marks are shown on older plans, those plans may have precedence over newer ones. More recent surveys that are not part of the official record are often obtained or purchased from local surveying firms that previously worked in the area.

The fieldwork itself is relatively straightforward. The process begins with locating existing boundary marks. Unlike in Slovenia, boundary marks here generally do not have published coordinates. Instead, they are initially located using metal detectors. Modern boundary marks are typically solid metal bars measuring 2.5 cm by 2.5 cm (1 inch by 1 inch) in cross-section and between 60 and 120 cm (2 to 4 feet) in length and buried approximately 10 to 20 cm below ground level. Older boundary marks may also take the form of hollow metal pipes with a diameter of 2.5 cm (1 inch).

If the boundary mark cannot be found on the subject property, the search expands to neighbouring land plots. It is also common practice to look for boundary marks tens of metres away from the client's property on the same side of the street, since all marks are generally

aligned along a common line at the same offset from the road centreline. This offset depends on the road classification and width and typically ranges from 33 to approximately 66 feet from the centreline of the roadway. These boundary marks are later used to more accurately calculate the position and orientation of the land plot before the final boundary marking is carried out. During the process of locating boundary marks, all successfully found marks are surveyed in either a local or provincial coordinate system. In addition to boundary points, the footprint of the client's building foundation and the footprints of structures immediately adjacent to the client's property line, both to the left and right, are also surveyed.

A typical land cadastral survey rarely exceeds 30 points surveyed before the work moves back to the office. There, a drafter compares the collected field data with documentation obtained from municipal offices or from local surveying firms that have previously worked in the surrounding area. The office work involves checking distances between boundary marks, verifying angles between property lines and determining foundation offsets from the property boundaries.

If boundary marks were not found in the field, the positions of new boundary marks are calculated based on distances and angles between existing boundary marks whose locations were successfully determined. Once the office calculations are complete, the data are sent back to the field crew, which returns to the site to perform the final staking of the property boundaries. During this process, all newly placed boundary marks are surveyed again for documentation purposes. Another interesting aspect is that neither the client nor neighbouring property owners are typically present during the staking process. In most cases, the entire job is completed within two working days. The first day, usually requiring four to six hours, is dedicated to locating existing boundary marks. The final staking, which usually takes place about one week later, requires only one or two additional hours of fieldwork. As a result, the total amount of fieldwork for most boundary surveys does not exceed a single working day.

It is also noteworthy that the final subdivision plan and report on the new boundary marks provided to the client and municipal authorities generally do not include coordinates. Instead, they contain only dimensions, offsets and angles, where applicable, if those values have changed as part of the subdivision process.

Personally, I quickly found land cadastral surveying somewhat monotonous, although it is relatively undemanding physically, except during winter when temperatures can drop to −30 °C and searching for boundary marks becomes far less enjoyable. After less than a year in land cadastral surveying, I began seeking new challenges in high-rise construction projects in downtown Toronto and later returned to railway projects, where I continue to work today.

KEY WORDS: land, land cadastre, Canada

Žiga Zadnik, dipl. inž. geod.
Ledcor, 2 International Blvd, Etobicoke, Ontario, M9W 1A2, Kanada
e-naslov: zigazadnik@gmail.com

Zlata doba opazovanja Zemlje – kako vsakodnevni visokoločljivi posnetki spreminjajo razumevanje prostora

The golden age of Earth observation – How daily high-resolution images are changing our understanding of space

prof. dr. Krištof Oštir

POVZETEK

Opazovanje Zemlje vstopa v obdobje, ko satelitski posnetki niso več občasni arhivski zapisi, temveč (skoraj) vsakodnevni podatkovni tokovi o stanju prostora. Program Copernicus s sateliti Sentinel-2 sistematično zagotavlja brezplačne multispektralne posnetke z ločljivostjo do 10 m in visoko časovno ponovljivostjo, komercialne konstelacije, kot je PlanetScope, pa omogočajo (skoraj) dnevno spremljanje površja pri približno 3–4 m ločljivosti, visokoločljive storitve pa se približujejo decimetrskemu razredu. Takšna kombinacija prostorske, spektralne in časovne ločljivosti odpira nove možnosti za spremljanje rabe tal, kmetijstva, gozdov, voda, urbanega razvoja, naravnih nesreč, podnebnih sprememb, infrastrukture in varnosti. Čeprav imajo pogosti posnetki Sentinel in še posebej Planet tudi pomembne geometrijske in radiometrične izzive, je njihova največja vrednost v zgoščenih časovnih vrstah, ki omogočajo tematske interpretacije sprememb in procesov. Strojno učenje, globoko učenje in nove oblike geoprostorske umetne inteligence zmanjšujejo del teh ovir, saj omogočajo avtomatizirano zaznavanje sprememb, razpoznavanje objektov, izboljšanje kakovosti podatkov in hitrejšo pripravo analiz. Hkrati pa tehnologija ne zmanjšuje pomena domenskega znanja; nasprotno, večja dostopnost orodij pomeni, da so kakovostno izobraževanje, razumevanje podatkov, kritična presoja rezultatov in povezovanje geoinformatike z znanjem posameznih področij še pomembnejši. Prispevek predstavlja trende v sodobnem opazovanju Zemlje ter z izbranimi primeri pokaže, kako umetna inteligenca geoinformatikom omogoča, da iz vsakodnevnih visokoločljivih posnetkov hitreje in zanesljiveje ustvarjajo uporabno prostorsko znanje.

KLJUČNE BESEDE: opazovanje Zemlje, satelitski posnetki, Sentinel, Planet, umetna inteligenca, geoinformatika

SUMMARY

Earth Observation is entering an era in which satellite images are no longer occasional archive records, but (almost) daily data streams describing the state and dynamics of space. The Copernicus programme, through the Sentinel missions, provides systematic and freely available multispectral imagery at resolutions of up to 10 m and with high revisit frequency, while commercial constellations such as PlanetScope enable near-daily monitoring of the Earth's surface at approximately 3–4 m resolution, with high-resolution tasking services moving towards the sub-metre scale. This combination of spatial, spectral and temporal resolution opens new applications in land-cover and land-use monitoring, agriculture, forestry, water management, urban development, disaster response, climate-change assessment, infrastructure monitoring and security. Although frequently acquired Sentinel and Planet imagery still faces important geometric and radiometric challenges, its most valuable advantage lies in dense time series that support thematic interpretation of changes and processes. Machine learning, deep learning and emerging forms of geospatial artificial intelligence help reduce these limitations by enabling automated change detection, object

recognition, data-quality improvement and faster analytical workflows. At the same time, technology does not diminish the importance of domain knowledge; on the contrary, the broader availability of tools makes education, critical interpretation of data and the integration of geoinformatics with expert knowledge in application domains even more essential. This contribution presents key global trends in modern Earth Observation and illustrates, through selected examples, how artificial intelligence enables geoinformatics professionals to transform daily high-resolution imagery into timely, reliable and actionable spatial knowledge.

KEY WORDS: Earth Observation, satellite imagery, Sentinel, Planet, artificial intelligence, geoinformatics

prof. dr. Krištof Oštir, univ. dipl. fiz.
Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Jamova cesta 2, 1000 Ljubljana
e-naslov: kristof.ostir@fgg.uni-lj.si

Dosežki slovenskega satelita NEMO-HD

Achievements of the Slovenian satellite NEMO-HD

prof. dr. Tomaž Rodič

POVZETEK

Misija NEMO-HD predstavlja pomemben mejnik v razvoju slovenskih vesoljskih zmogljivosti in tehnologij za opazovanje Zemlje. Razvil jo je Center odličnosti Vesolje-SI v sodelovanju s Space Flight Laboratory (SFL) Univerze v Torontu. NEMO-HD je postal prvi slovenski mikrosatelit. Uspešno je bil izstreljen 2. septembra 2020 z nosilno raketo Vega v okviru misije VV16 iz Francoske Gvajane ter dokazal, da lahko majhen in okreten satelit iz nizke Zemljine orbite zagotavlja multispektralne in videoposnetke visoke ločljivosti. Ključni dosežek misije NEMO-HD je demonstracija inovativnega koncepta opazovanja Zemlje, ki združuje visokoločljivostno multispektralno slikanje in zajem videa visoke ločljivosti. Satelit deluje na višini približno 520 km ter zagotavlja pankromatske posnetke z ločljivostjo 2,8 m in multispektralne posnetke z ločljivostjo približno 5,6 m v štirih spektralnih območjih: modrem, zelenem, rdečem in bližnjem infrardečem. Dopolnilni širokokotni instrument zagotavlja približno 40-metrsko ločljivost na bistveno širšem območju. Oba instrumenta omogočata zajem videa visoke ločljivosti, kar omogoča spremljanje dinamičnih pojavov, ki jih s klasičnimi satelitskimi posnetki ni mogoče ustrezno zajeti.

NEMO-HD je dokazal zanesljivost, okretnost in natančen nadzor orientacije majhne satelitske platforme pri zahtevnih nalogah opazovanja Zemlje. Posnetki so bili uporabljeni za opazovanje mest, pristanišč, letališč, rudnikov, rek ter drugih območij gospodarskega in okoljskega pomena. Satelitski video je odprl nove možnosti za spremljanje dinamičnih pojavov, vključno s kopenskim, pomorskim, rečnim in zračnim prometom, multispektralni podatki pa podpirajo okoljsko spremljanje ter razvoj okoljskih in gospodarskih kazalnikov.

Pomemben dosežek je tudi integracija satelita z zemeljsko infrastrukturo in sistemi za obdelavo podatkov SPACE-SI. Mobilna zemeljska postaja STREAM omogoča interaktivno upravljanje satelita in hiter prenos podatkov, avtomatizirana procesna veriga STORM pa surove satelitske podatke pretvori v uporabne, kartografsko pripravljene izdelke. Skupaj te zmogljivosti tvorijo celovit sistem od zajema podatkov v vesolju do njihovega prenosa, obdelave in uporabe ter skrajšujejo čas od opazovanja do pridobitve uporabnih informacij.

Z zmogljivostmi NEMO-HD so bile izvedene tudi aplikacije na področju okoljskega spremljanja, med drugim opazovanje porečij in povezovanje podatkov NEMO-HD s podatki satelita Sentinel-2. NEMO-HD je tako vzpostavil inovativen in stroškovno učinkovit model odzivnega opazovanja Zemlje z uporabo hitrih komunikacij in avtomatizirane obdelave podatkov. Misija je pomembno okrepila slovensko znanje na področju satelitskega inženirstva, upravljanja misij in daljinskega zaznavanja ter ustvarila trdne temelje za prihodnje misije in aplikacije na področju spremljanja okolja, infrastrukture, odzivanja ob nesrečah in trajnostnega upravljanja naravnih virov.

KLJUČNE BESEDE: mikrosatelit NEMO-HD, opazovanje Zemlje z večspektralnimi in videosenzorji

SUMMARY

The NEMO-HD mission represents an important milestone in the development of Slovenian space capabilities and Earth observation technologies. It was developed by the Centre of Excellence SPACE-SI in cooperation with the Space Flight Laboratory (SFL) at the University of Toronto. NEMO-HD became the first Slovenian microsatellite. It was successfully launched on 2 September 2020 aboard a Vega launch vehicle as part of the VV16 mission from French Guiana, demonstrating that a small and agile satellite operating in low Earth orbit can provide high-resolution multispectral and video imagery.

A key achievement of the NEMO-HD mission is the demonstration of an innovative Earth observation concept that combines high-resolution multispectral imaging with high-resolution video acquisition. The satellite operates at an altitude of approximately 520 km and provides panchromatic imagery with a resolution of 2.8 m and multispectral imagery with a resolution of approximately 5.6 m in four spectral bands: blue, green, red and near-infrared. A complementary wide-angle instrument provides approximately 40 m resolution over a substantially larger area. Both instruments enable high-resolution video acquisition, making it possible to monitor dynamic phenomena that cannot be adequately captured using conventional satellite imagery.

NEMO-HD has demonstrated the reliability, agility and precise attitude control of a small satellite platform during demanding Earth observation tasks. The imagery has been used to observe cities, ports, airports, mines, rivers and other areas of economic and environmental importance. Satellite video has opened up new possibilities for monitoring dynamic phenomena, including land, maritime, river and air traffic, while multispectral data support environmental monitoring and the development of environmental and economic indicators.

Another important achievement is the integration of the satellite with ground infrastructure and the SPACE-SI data processing systems. The STREAM mobile ground station enables interactive satellite operations and rapid data transfer, while the automated STORM processing chain transforms raw satellite data into usable, cartographically prepared products. Together, these capabilities form an integrated system spanning the entire process from data acquisition in space to transmission, processing and application, thereby reducing the time between observation and the delivery of useful information.

The capabilities of NEMO-HD have also been used in environmental monitoring applications, including watershed observation and the integration of NEMO-HD data with data from the Sentinel-2 satellite. NEMO-HD has thus established an innovative and cost-effective model for responsive Earth observation through the use of high-speed communications and automated data processing. The mission has significantly strengthened Slovenian expertise in satellite engineering, mission operations and remote sensing, while creating a strong foundation for future missions and applications in environmental monitoring, infrastructure monitoring, disaster response and the sustainable management of natural resources.

KEY WORDS: NEMO-HD microsatellite, Earth observation, multispectral and video sensors

prof. dr. Tomaž Rodič
VESOLJE-SI, Aškerčeva 12, 1000 Ljubljana
e-naslov: tomaz.rodic@space.si

Motenje signalov GNSS: do kolikšne mere se lahko še zanašamo na GNSS?

GNSS signal interference: To what extent can we still rely on GNSS?

izr. prof. dr. Polona Pavlovčič Prešeren

POVZETEK

Sodobna družba je močno odvisna od GNSS (angl. Global Navigation Satellite Systems), ki danes ne služijo le določanju položaja, temveč tudi vzpostavitvi koordinatnih sistemov, navigaciji in sinhronizaciji časa. Poleg geodezije imajo satelitski navigacijski sistemi ključno vlogo v letalstvu, pomorstvu, prometu, telekomunikacijah in elektroenergetiki, kjer natančna časovna usklajenost omogoča stabilno delovanje omrežij. Zaradi vse večje odvisnosti infrastrukture od GNSS pa postaja vprašanje zanesljivosti signalov vedno pomembnejše, zlasti v času povečane globalne nestabilnosti, vojaških konfliktov ter vse pogostejših primerov motenja satelitskih signalov.

Prispevek opisuje problematiko namernega motenja signalov GNSS ter vprašanje, do kolikšne mere se lahko danes še zanašamo na GNSS pri geodetskem delu in v drugih kritičnih sistemih. Poseben poudarek bo namenjen pojavoma nezmožnosti sprejema signalov GNSS (angl. jamming) in pošiljanja potvorjenih signalov (angl. spoofing), ki sta v zadnjih letih postala izrazito aktualna zaradi povečane globalne nestabilnosti ter vojaških konfliktov. Predstavljeni bodo tudi nekateri sodobni pristopi zaznavanja motenj, med drugim spektralne analize signalov GNSS, ter možnosti ugotavljanja napadov na signale Galileo preko zaščite signalov OSNMA (angl. Open Service Navigation Message Authentication), ki omogoča preverjanje avtentičnosti navigacijskih sporočil.

V geodeziji imajo takšni vplivi posebej resne posledice, saj lahko povzročijo napačne koordinate, slabšanje kakovosti določitve koordinat ali celo neuporabnost koordinat izmere. Zaradi tega postaja vedno pomembnejše preverjanje kakovosti opazovanj GNSS ter zagotavljanje sledljivosti meritev. V prispevku bomo predstavili pomen shranjevanja surovih opazovanj GNSS (binarni formati ali format RINEX), ki omogočajo naknadno analizo meritev, preverjanje integritete signalov ter odkrivanje napak v podatkih. Shranjevanje surovih opazovanj postaja pomemben element zagotavljanja kakovosti in zanesljivosti geodetskih meritev, zlasti pri uradnih in dolgoročno pomembnih izmerah. Namen predavanja je opozoriti na ranljivost sodobnih sistemov, ki se nanašajo na GNSS, ter spodbuditi razmislek o tem, kako zagotoviti zanesljivo uporabo tehnologije v geodeziji tudi v razmerah povečanih motenj signalov.

KLJUČNE BESEDE: GNSS, namerno motenje signalov, onemogočanje sprejema signalov, sprejem lažnih signalov, zaščita signalov OSNMA, geodetske meritve, arhiv opazovanj GNSS

SUMMARY

Modern society is highly dependent on GNSS (Global Navigation Satellite Systems), which today are used not only for positioning but also for the establishment of coordinate systems, navigation and time synchronisation. In addition to geodesy, satellite navigation systems play a crucial role in aviation, maritime transport, traffic, telecommunications and power engineering, where precise time synchronisation enables the stable operation of networks. Due to the increasing dependence of infrastructure on GNSS, the reliability of satellite signals

is becoming an increasingly important issue, especially in times of growing global instability, military conflicts and the increasing occurrence of satellite signal interference.

This paper addresses the problem of intentional GNSS signal interference and the question of to what extent GNSS can still be relied upon in geodetic work and other critical systems. Special emphasis is placed on the phenomena of GNSS signal denial (jamming) and the transmission of falsified signals (spoofing), both of which have become highly relevant in recent years due to increasing global instability and military conflicts. The paper also presents several possible approaches for interference detection, including spectral analysis of GNSS signals, as well as possibilities for detecting attacks on Galileo signals through the OSNMA (Open Service Navigation Message Authentication) signal authentication service, which enables verification of the authenticity of navigation messages.

In geodesy, such impacts can have particularly serious consequences, as they may lead to incorrect coordinates, degradation of coordinate quality or even unusable survey results. Therefore, the verification of GNSS observation quality and the traceability of measurements are becoming increasingly important. The paper will present the importance of storing raw GNSS observations (binary or RINEX formats), which allow subsequent analysis of measurements, verification of signal integrity and detection of anomalies in the data. The storage of raw observations is becoming an important element in ensuring the quality and reliability of geodetic measurements, especially in official and long-term significant surveys. The aim of the lecture is to highlight the vulnerability of modern systems relying on GNSS and to encourage discussion on how to ensure the reliable use of GNSS technology in geodesy even under conditions of increased signal interference.

KEY WORDS: GNSS, intentional signal interference, jamming, spoofing, OSNMA signal authentication, geodetic measurements, GNSS observation archive

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izr. prof. dr. Polona Pavlovčič Prešeren, univ. dipl. inž. geod.
Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Jamova cesta 2, 1000 Ljubljana
e-naslov: polona.pavlovcic-preseren@fgg.uni-lj.si

Zanesljiv GeoAI temelji na semantični infrastrukturi

Trusted GeoAI has its foundation in semantic infrastructure

Gregor Završnik, doc. dr. Marjan Čeh, Vid Primožič

POVZETEK

Uvajanje AI v obliki agentskih sistemov nad prostorskimi evidencami napreduje hitreje kot razmislek o tem, kaj pomeni zanesljiv odgovor takega sistema. V upravnem in pravnem okolju zanesljivost ni le točnost posameznega odgovora, temveč predvsem njegova ponovljivost in sledljivost: isto vprašanje nad istim stanjem evidence mora dati isti odgovor, ne glede na to, kdo ga zastavi, kdaj in s katerim modelom. Prav ponovljivosti in sledljivosti osnovni pristopi GeoAI praviloma ne zagotavljajo.

Vir te nestabilnosti je v sami naravi jezikovnih modelov, ki temeljijo na statistični metodi. Zato potrebujemo komplementarno enovito strojno berljivo bazo znanja o pomenu izrazov in uporabljenih postopkih. Že pri ljudeh pride do nesporazumov, ko vsi izrazi niso jasno dokumentirani. Zato tudi AI potrebuje definicije atributov in šifrantov v strojno berljivi obliki slovarjev z obstojnimi enoličnimi identifikatorji, opredeljeno časovno veljavnost z upravljanjem verzij ter eksplicitno izraženo raven kakovosti. Brez teh informacij model manjkajoči pomen ugiba in vsako tako ugibanje je vir alternativnih odgovorov, ki ne omogočajo sledljivosti. To naredi sisteme nezanesljive.

Semantična infrastruktura predstavlja samostojen sloj arhitekture AI, ki sistemu pove troje: pomen podatka, njegov izvor in pod kakšnimi pogoji je veljaven. Njeno jedro so taksonomije (hierarhija pojmov) in ontologije (razmerja med pojmi), ki omogočajo strojno preverljivost. Nanje se navezujejo kontrolirani slovarji z enoličnimi in obstojnimi identifikatorji, pravila skladnosti ter semantični kazalniki kakovosti, ki ovrednotijo primernost vira za določeno vprašanje. Podlago za vse to predstavljajo ključni standardi iz skupine ISO 191xx.

Zanesljivost sistema GeoAI zahteva tudi dosledno dokumentiranje postopka, po katerem je odgovor nastal. Predpogoj za to je usklajeno in sledljivo upravljanje podatkov (skrbništvo nad viri in slovarji, upravljanje različic, dokumentiran izvor in spremembe, revizijska sled postopkov). Obstoječe sisteme beleženja revizijske sledi moramo prenesti v okolje AI. Brez take sledi odgovor agenta ostaja brez dokazne vrednosti in ne more biti podlaga za odločanje v upravnem postopku, tudi če je vsebinsko pravilen.

V drugem delu prikažemo, kako se te zahteve prevedejo v zasnovo agentov. Prosto sklepanje modela nadomestimo z opredeljenimi uporabniškimi primeri in predpisanimi postopki. Agent tako izvede določeno zaporedje korakov nad določenimi viri, vsak korak pa pusti sled. Ponovljivost tako zagotavlja zasnova AI sistema. Predstavili bomo shematski prikaz take arhitekture in njeno obnašanje na izbranem uporabniškem primeru iz javne evidence.

Na koncu predstavimo posledice za upravljavce evidenc: objava šifrantov kot vzdrževanih slovarjev, dokumentiranje pomena atributov, pravila preverjanja in merjenje semantične kakovosti. Odpremo tudi vprašanja upravljanja, ki jih uporaba podatkov v GeoAI orodjih zahteva: kdo slovarje vzdržuje, kdo odgovarja za napačen strojni odgovor in kako je tak odgovor mogoče revidirati.

KLJUČNE BESEDE: semantična infrastruktura, GeoAI, ponovljivost, ontologije, upravljanje podatkov, javne evidence

SUMMARY

AI is being deployed as agent-based systems over spatial registers faster than we have settled what a reliable answer from such a system means. In administrative and legal settings, reliability is not only the accuracy of a single answer but above all its reproducibility and traceability: the same question over the same state of a register must yield the same answer, regardless of who asks it, when and with which model. Basic GeoAI approaches generally provide neither.

This instability stems from the statistical nature of language models themselves. They need a complementary, unified machine-readable knowledge base on the meaning of terms and the procedures applied. Even among people, misunderstandings arise when terms are not clearly documented. AI likewise needs attribute and code-list definitions as machine-readable vocabularies with persistent unique identifiers, defined temporal validity under version control and an explicitly stated quality level. Without this, the model guesses the missing meaning, and every guess produces alternative, untraceable answers. This makes such systems unreliable.

Semantic infrastructure is a distinct layer of the AI architecture that tells the system three things: what the data means, where it comes from and under what conditions it is valid. At its core are taxonomies (a hierarchy of concepts) and ontologies (relations between concepts), which enable machine verification. Building on them are controlled vocabularies with unique persistent identifiers, conformance rules and semantic quality indicators that assess a source's fitness for a given question. The basis is the key standards of the ISO 191xx family.

A reliable GeoAI system also requires consistent documentation of the procedure that produced the answer. This presupposes coordinated, traceable data governance: stewardship of sources and vocabularies, version control, documented provenance and changes and an audit trail of procedures. Existing audit-trail systems must be carried over into the AI environment. Without such a trail, an agent's answer carries no evidentiary value and cannot serve as a basis for an administrative decision, even when substantively correct.

The second part shows how these requirements translate into agent design. Free reasoning by the model is replaced by defined use cases and prescribed procedures. The agent executes a defined sequence of steps using specified sources, and every step leaves a trace. Reproducibility is thus secured by the design of the AI system. We will present a schematic view of this architecture and its behaviour on a selected use case from a public register.

We close with the implications for register custodians: publishing code lists as maintained vocabularies, documenting the meaning of attributes, conformance rules and measuring semantic quality. We also raise the governance questions that using such data in GeoAI tools demands: who maintains the vocabularies, who is accountable for an incorrect machine answer and how it can be audited.

KEY WORDS: semantic infrastructure, GeoAI, reproducibility, ontologies, data governance, public registers

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Gregor Završnik, univ. dipl. inž. geod.
Geoarh, Gregor Završnik, s.p., Trpinčeva ulica 72, SI-1000 Ljubljana
e-naslov: gregor@geoarh.si

doc. dr. Marjan Čeh, univ. dipl. inž. geod.
Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Jamova cesta 2, SI-1000 Ljubljana
e-naslov: marjan.ceh@fgg.uni-lj.si

Vid Primožič, univ. dipl. inž. geod.
Flycom Technologies d. o. o., Celovška cesta 520, SI-1210 Ljubljana - Šentvid
e-naslov: vid.primozic@flycom.si

Zemlja brez meja: geoprostorski digitalni dvojček Slovenije – VAIKARDD

Earth without borders: Slovenia's geospatial digital twin – VAIKARDD

mag. Erna Flogie Dolinar, Andraž Muhič, prof. dr. Anka Lisec

POVZETEK

Geoprostorski digitalni dvojček Slovenije predstavlja naslednji razvojni korak pri uporabi prostorskih podatkov. Na podlagi že vzpostavljene državne prostorske podatkovne infrastrukture omogoča prehod od prikazovanja stanja prostora k spremljanju njegovih sprememb skozi čas, njihovemu analiziranju in razumevanju ter uporabi pridobljenega znanja pri kompleksnih prostorskih odločitvah. Pri tem ne gre zgolj za digitalno vizualizacijo prostora, temveč za njegovo dinamično digitalno reprezentacijo, ki povezuje prostorsko in časovno razsežnost ter predstavlja osnovo za napredne analize, simulacije in napovedovanje. Temeljni koncept razvoja geoprostorskega digitalnega dvojčka Slovenije je bil pripravljen v okviru ciljnega raziskovalnega projekta (CRP) z naslovom »Priprava koncepta razvoja geoprostorskega digitalnega dvojčka Slovenije za potrebe kompleksnih prostorskih odločitev države«, nadgradnja in izvedba predlaganih rešitev pa se bosta realizirali v okviru projekta z imenom »Vstopimo v digitalni prostor - VAIKARDD«.

Projekt VAIKARDD predstavlja logično nadaljevanje razvojnih aktivnosti na področju prostorskih podatkov in storitev, ki so se izvajale v projektih eProstor in Zeleni slovenski lokacijski okvir (SLO4D). Nadgrajuje že vzpostavljene in povezane prostorske podatke, evidence, informacijske sisteme in storitve ter jih povezuje z razvojem Geoprostorskega digitalnega dvojčka Slovenije. Pomembna usmeritev projekta je ob tehnološkem razvoju tudi krepitev znanja, razumevanja in kompetenc za učinkovito uporabo že zgrajenih sistemov, novih podatkovnih virov ter 3D- in 4D-modelov. VAIKARDD tako povezuje nadaljnji razvoj geoprostorske podatkovne infrastrukture z razvojem znanja in sposobnosti za njeno uporabo pri reševanju konkretnih prostorskih izzivov.

Geoprostorski digitalni dvojček je zasnovan kot dinamična digitalna reprezentacija realnega prostora, ki združuje več ključnih podatkovnih slojev ter omogoča njihovo obravnavo v prostorski in časovni razsežnosti. Med njimi imajo pomembno vlogo zgodovinski prostorski podatki, ki predstavljajo zapis razvoja prostora skozi čas. Pomembnejši podatki, ki jih bo vključeval, so georeferencirani aeroposnetki iz različnih obdobij, digitaliziran arhiv več kot 200-letnega katastra ter časovne vrste prostorskih evidenc, ki omogočajo spremljanje prostorskih sprememb in analiziranje razvoja prostora. Povezovanje zgodovinskih in aktualnih podatkov omogoča prehod od prikaza posameznega stanja prostora k spremljanju in razumevanju njegovega razvoja skozi čas.

Temelj za izgradnjo geoprostorskega digitalnega dvojčka predstavlja državna geodetska in prostorska podatkovna infrastruktura, ki zagotavlja enoten in zanesljiv referenčni prostorski okvir za različne podatke in sisteme. Ta vključuje tudi temeljno državno geodetsko infrastrukturo, in sicer referenčne prostorske koordinatne sisteme. Na tej osnovi se lahko preko lokacije povezujejo temeljne prostorske evidence, med katere sodijo kataster nepremičnin, topografski in kartografski podatki, evidence gospodarske javne infrastrukture ter registri prostorskih enot in zemljepisnih imen. Skupna lokacijska referenca hkrati omogoča povezovanje teh podatkov s podatki drugih državnih resorjev, lokalnih skupnosti, daljinskega zaznavanja, senzorjev in drugih virov.

Pomemben razvojni korak predstavlja tudi prehod iz tradicionalnih dvodimenzionalnih evidenc v 3D- in 4D-model prostora, ki poleg prostorske vključuje tudi časovno komponento. Z uporabo digitalnih modelov reliefa, podatkov laserskega skeniranja (lidar), 3D-modelov stavb, satelitskih podatkov, drugih podatkov daljinskega zaznavanja ter podatkov iz senzorjev bo mogoče ustvariti t. i. »digitalni prostorski film države«, ki bo prikazoval ne le trenutno stanje, temveč tudi spremembe skozi čas. Časovna komponenta omogoča primerjavo različnih stanj prostora, zaznavanje sprememb ter oblikovanje časovnih vrst, ki predstavljajo pomembno osnovo za razumevanje procesov v prostoru, izvajanje analiz in napovedovanje. Digitalni dvojček bo omogočal izvajanje naprednih analiz, simulacij in modelov za podporo odločanju na področjih prostorskega razvoja, graditve, varstva okolja, infrastrukture in upravljanja nepremičnin.

Med ključnimi prednostmi geoprostorskega digitalnega dvojčka so celovita pokritost ozemlja države, vključno s težje dostopnimi območji, redno osveževanje podatkov, zagotavljanje objektivnih in med seboj primerljivih podatkov skozi čas ter povezovanje državnih evidenc s podatki daljinskega zaznavanja, senzorjev in lokalnih uporabnikov. Takšen sistem omogoča bistveno bolj zanesljiv vpogled v stanje prostora in hitrejše odzivanje na prostorske spremembe. Pomembna dodana vrednost je možnost povezovanja zaznanih sprememb s konkretnimi prostorskimi objekti, kot so parcela, stavba ali infrastruktura, ter s procesi in odločitvami, ki se nanje nanašajo.

Vloga geoprostorskega digitalnega dvojčka presega zgolj zbiranje in prikaz podatkov. Predstavlja skupno geoprostorsko osnovo države za zaznavanje in spremljanje sprememb ter za izvajanje analiz, simulacij in napovednih modelov. Kakovostna, časovno opredeljena in prostorsko referencirana podatkovna osnova ustvarja tudi pomembne pogoje za razvoj in uporabo umetne inteligence in GeoAI, zlasti pri avtomatiziranem zaznavanju sprememb, analizi prostorskih vzorcev ter podpori kompleksnim prostorskim analizam in odločanju.

Hkrati bo geoprostorski digitalni dvojček služil kot skupna prostorska in podatkovna podlaga za razvoj različnih vsebinskih oziroma sektorskih digitalnih dvojčkov s področij prometa, okolja, voda, energetike, dostopa ranljivih skupin in tudi drugih sektorjev. Geoprostorski digitalni dvojček tako ne nadomešča sektorskih digitalnih dvojčkov, temveč jim zagotavlja skupen referenčni prostor, temeljne podatke in pogoje za njihovo medsebojno povezovanje. S tem bo postal ključna infrastruktura za razumevanje prostora in podporo podatkovno vodenemu odločanju države v digitalni dobi.

Pomemben del projekta VAIKARDD je tudi razvoj Centra znanja, namenjenega sistematičnemu učenju, usposabljanju, prenosu znanja in razvoju novih kompetenc na področju geoprostorskih podatkov in tehnologij. Center znanja predstavlja povezavo med tehnološko in podatkovno infrastrukturo na eni strani ter ljudmi, ki morajo zgrajene sisteme razumeti, učinkovito uporabljati in nadalje razvijati, na drugi. Razvoj geoprostorskega digitalnega dvojčka zato ni zgolj tehnološki projekt, temveč tudi proces razvoja znanja in institucionalnih sposobnosti za uporabo podatkov pri razumevanju prostora in odločanju.

V tem smislu projekt VAIKARDD pomeni razvojni premik od zgrajenih podatkov in sistemov k njihovemu razumevanju in uporabi: od sposobnosti zaznavanja sprememb v prostoru k njihovemu razumevanju, analiziranju in napovedovanju ter od pridobljenega znanja k boljšim prostorskim odločitvam. Geoprostorski digitalni dvojček tako povezuje podatkovno in tehnološko infrastrukturo, znanje ter procese odločanja in ukrepanja v prostoru.

Rezultati projekta bodo pomembno prispevali k nadaljnjemu razvoju nalog Geodetske uprave Republike Slovenije na področjih geodezije, nepremičnin in množičnega vrednotenja

nepremičnin ter k izboljšanju procesov Ministrstva za naravne vire in prostor na področju urejanja prostora in graditve. Hkrati bodo ustvarjeni pogoji za širšo uporabo skupne geoprostorske infrastrukture na drugih področjih delovanja države in lokalnih skupnosti, kjer imajo odločitve prostorsko razsežnost. Geoprostorski digitalni dvojček Slovenije tako predstavlja enega najpomembnejših korakov k celoviti digitalni preobrazbi upravljanja prostora in vzpostavitvi sodobnega podatkovnega ekosistema za prihodnje generacije.

KLJUČNE BESEDE: geoprostorski digitalni dvojček, državna prostorska podatkovna infrastruktura, 4D-model prostora, VAIKARDD

SUMMARY

The Geospatial Digital Twin of Slovenia represents the next stage in the evolution of spatial data utilisation. Building on the already established national spatial data infrastructure, it enables a transition from merely depicting the state of space to monitoring its changes over time, analysing and understanding these changes and applying the acquired knowledge to support complex spatial decision-making. It is not simply a digital visualisation of space, but rather a dynamic digital representation that integrates spatial and temporal dimensions and serves as a foundation for advanced analyses, simulations and forecasting.

The fundamental concept for the development of the Geospatial Digital Twin of Slovenia was prepared within the targeted research project (CRP) entitled "Preparation of the Development Concept for the Geospatial Digital Twin of Slovenia to Support Complex National Spatial Decision-Making". The enhancement and implementation of the proposed solutions will be carried out within the project "Entering the Digital Space – VAIKARDD".

The VAIKARDD project represents a logical continuation of development activities in the field of spatial data and services previously undertaken through the eProstor and Green Slovenian Location Framework (SLO4D) projects. It builds upon already established and interconnected spatial datasets, registers, information systems and services, integrating them into the development of the Geospatial Digital Twin of Slovenia. Alongside technological advancement, a key objective of the project is the strengthening of knowledge, understanding and competencies required for the effective use of existing systems, new data sources and 3D and 4D models. VAIKARDD therefore combines the further development of geospatial data infrastructure with the development of knowledge and capabilities needed to address real-world spatial challenges.

The Geospatial Digital Twin is designed as a dynamic digital representation of the real world, integrating multiple key data layers and enabling their management within both spatial and temporal dimensions. Among these, historical spatial data play a particularly important role, as they document the development of space over time. Key datasets to be included are georeferenced aerial imagery from various periods, a digitised archive of more than 200 years of cadastral records and time series of spatial registers that enable monitoring of spatial changes and analysis of spatial development. By linking historical and current datasets, the system enables a transition from viewing a single snapshot of space to understanding its evolution through time.

The foundation of the Geospatial Digital Twin is the national geodetic and spatial data infrastructure, which provides a unified and reliable spatial reference framework for various datasets and systems. This infrastructure includes the fundamental national geodetic

framework, namely the official spatial reference coordinate systems. Based on this framework, core spatial registers can be connected through location, including the Real Estate Cadastre, topographic and cartographic datasets, utility infrastructure records and registers of spatial units and geographical names. At the same time, the common location reference enables the integration of these datasets with information from other government sectors, local communities, remote sensing sources, sensors and additional data providers.

An important development step is also the transition from traditional two-dimensional records to a 3D and 4D model of space that incorporates both spatial and temporal components. Through the use of digital terrain models, laser scanning (LiDAR) data, 3D building models, satellite imagery, other remote sensing datasets and sensor-derived information, it will be possible to create a so-called "digital spatial movie of the country", depicting not only the current state of space but also its evolution over time. The temporal dimension enables the comparison of different states of space, the detection of changes and the establishment of time series that form an essential basis for understanding spatial processes, conducting analyses and generating forecasts. The digital twin will support advanced analyses, simulations and modelling for decision-making in the fields of spatial development, construction, environmental protection, infrastructure management and real estate administration.

Among the key advantages of the Geospatial Digital Twin are comprehensive nationwide coverage, including hard-to-access areas, regular updating of datasets, provision of objective and temporally comparable information and integration of official registers with remote sensing, sensor and local user data. Such a system provides a significantly more reliable understanding of spatial conditions and enables quicker responses to spatial changes. An important added value is the ability to connect detected changes directly to specific spatial objects, such as parcels, buildings or infrastructure, as well as to the processes and decisions associated with them.

The role of the Geospatial Digital Twin extends far beyond data collection and visualisation. It serves as the common geospatial foundation of the country for detecting and monitoring changes conducting analyses, simulations and predictive modelling. High-quality, time-referenced and spatially referenced datasets also create important preconditions for the development and application of artificial intelligence (AI) and GeoAI, particularly in automated change detection, spatial pattern analysis and support for complex spatial analyses and decision-making processes.

At the same time, the Geospatial Digital Twin will serve as a common spatial and data foundation for the development of various thematic or sector-specific digital twins in fields such as transportation, environment, water resources, energy, accessibility for vulnerable groups and other sectors. The Geospatial Digital Twin does not replace sectoral digital twins; instead, it provides them with a common spatial reference framework, fundamental datasets and conditions for interoperability. In this way, it will become a key infrastructure for understanding space and supporting data-driven decision-making in the digital age.

An important component of the VAIKARDD project is the development of a Knowledge Centre dedicated to systematic learning, training, knowledge transfer and the development of new competencies in the field of geospatial data and technologies. The Knowledge Centre forms a bridge between technological and data infrastructure on one side and the people who must understand, effectively use and further develop these systems on the other. Consequently, the development of the Geospatial Digital Twin is not only a technological

endeavour but also a process of building knowledge and institutional capacities for applying data to spatial understanding and decision-making.

In this sense, the VAIKARDD project represents a developmental shift from merely creating data and systems towards understanding and utilising them: from the ability to detect spatial changes to understanding, analysing and predicting them and from acquired knowledge towards better spatial decisions. The Geospatial Digital Twin therefore integrates data and technological infrastructure, knowledge and decision-making and action processes within space.

The project results will make a significant contribution to the further development of the responsibilities of the Surveying and Mapping Authority of the Republic of Slovenia in the fields of geodesy, real estate and mass real estate valuation, as well as to the improvement of the processes of the Ministry of Natural Resources and Spatial Planning in the areas of spatial planning and construction. At the same time, conditions will be established for the broader use of a common geospatial infrastructure across other areas of government and local community activities where decisions have a spatial dimension.

The Geospatial Digital Twin of Slovenia therefore represents one of the most important steps towards the comprehensive digital transformation of spatial governance and the establishment of a modern data ecosystem for future generations.

KEY WORDS: geospatial digital twin, national spatial data infrastructure, 4D spatial model, VAIKARDD

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mag. Erna Flogie Dolinar, univ. dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: erna.flogie-dolinar@gov.si

Andraž Muhič, mag. inž. geod. geoinf.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: andraz.muhic@gov.si

prof. dr. Anka Lisec, univ. dipl. inž. geod.
Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo, Jamova cesta 2, 1000 Ljubljana
e-naslov: anka.lisec@fgg.uni-lj.si

Geo Slovenija: več kot infrastruktura

Geo Slovenia: Beyond infrastructure

Matjaž Grilc, Tomaž Petek

POVZETEK

Geo Slovenija že od začetka ni bila zamišljena zgolj kot tehnična infrastruktura. Je skupnost institucij, ljudi, podatkov, znanja, tehnologij in uporabnikov, ki na podlagi skupnih pravil omogoča povezovanje in uporabo prostorskih informacij. Hiter razvoj umetne inteligence tej skupnosti danes odpira nove razvojne možnosti, hkrati pa bistveno spreminja način, kako bodo prostorski podatki uporabljeni.

Dosedanji model distribucije podatkov je bil zgrajen predvsem za znanega človeškega uporabnika. Geodet, projektant, raziskovalec, javni uslužbenec ali državljan je obiskal portal, poiskal ustrezno zbirko oziroma storitev, prevzel podatke ter jih sam razložil in obdelal. V prihodnje bodo neposredni uporabniki prostorskih podatkov vse pogosteje veliki jezikovni modeli in drugi AI-agenti. Človek bo izrazil svojo potrebo, agent pa bo moral sam poiskati avtoritativne vire, razumeti pomen podatkov, preveriti njihov izvor, kakovost in časovno veljavnost, jih pravilno povezati ter iz njih sestaviti uporaben in preverljiv rezultat.

Za takšno uporabo zgolj tehnična dostopnost podatkov ne zadošča. Strojno razumljivi morajo postati tudi njihov pomen, odnosi med evidencami, pravila uporabe, metodologije in omejitve. Geo Slovenija se zato razvija v smeri platforme prostorske inteligence – skupnega okolja, ki povezuje avtoritativne podatke, prostorsko bazo znanja, semantiko, strokovna pravila, umetno inteligenco in človeško odgovornost. Platforma ne nadomešča matičnih evidenc in njihovih upravljavcev, temveč jim zagotavlja skupne zmogljivosti za uporabo podatkov, upravljanje znanja in umetne inteligence, namenjene stalnemu spremljanju prostora, izboljševanju kakovosti podatkov ter razvoju novih storitev in specializiranih agentov.

Kot ena ključnih referenčnih institucij Geo Slovenije želi GURS ta model uveljaviti v praksi in se postopoma razviti v agencijo za prostorsko inteligenco. VAIKARDD in geoprostorski digitalni dvojček Slovenije sta med prvimi pomembnimi instrumenti tega prehoda. Takšen razvoj bo omogočil lažje in zanesljivejše spremljanje sprememb v prostoru ter ljudem, lastnikom nepremičnin, gospodarstvu in javni upravi zagotovil hitrejše, kakovostnejše in bolj uporabne storitve. V središču razvoja tudi v prihodnje ostaja človek: umetna inteligenca lahko išče, povezuje, preverja in pripravlja predloge, odgovornost za uradni podatek, strokovno presojo in odločitev pa ostaja pri pristojnem strokovnjaku oziroma instituciji.

KLJUČNE BESEDE: Geo Slovenija, prostorska inteligenca, umetna inteligenca, AI-agenti, prostorski podatki, GURS

SUMMARY

From the outset, Geo Slovenia was not conceived merely as a technical infrastructure. It is a community of institutions, people, data, knowledge, technologies and users that enables the integration and use of spatial information based on common rules. The rapid development of artificial intelligence is opening up new development opportunities for this community, while fundamentally changing how spatial data will be used.

The existing data distribution model was designed primarily for a known human user. A surveyor, planner, researcher, public official or citizen visited a portal, found the appropriate dataset or service, downloaded the data and then interpreted and processed it. In the future, large language models and other AI agents will increasingly become the direct users of spatial data. A person will express a need, while an agent will have to identify authoritative sources, understand the meaning of the data, verify its origin, quality and temporal validity, connect it correctly and use it to produce a useful and verifiable result.

Technical accessibility of data alone is not sufficient for this type of use. The meaning of the data, the relationships between registers, rules of use, methodologies and limitations must also become machine-readable. Geo Slovenia is therefore evolving towards a Spatial Intelligence Platform – a shared environment connecting authoritative data, a spatial knowledge base, semantics, professional rules, artificial intelligence and human responsibility. The platform does not replace authoritative registers or their custodians. Instead, it provides shared capabilities for using data, managing knowledge and applying artificial intelligence to support continuous monitoring of the physical environment, improve data quality and develop new services and specialised agents.

As one of Geo Slovenia's key reference institutions, the Surveying and Mapping Authority of the Republic of Slovenia aims to put this model into practice and gradually develop into a spatial intelligence agency. VAIKARDD and Slovenia's geospatial digital twin are among the first major instruments of this transition. This development will enable easier and more reliable monitoring of changes in space and provide people, property owners, businesses and public authorities with faster, higher-quality and more useful services. People will remain at the centre of this development: artificial intelligence can search, connect, verify and prepare proposals, but responsibility for official data, professional assessment and decisions remains with the competent expert or institution.

KEY WORDS: Geo Slovenia, spatial intelligence, artificial intelligence, AI agents, spatial data, surveying authority

Matjaž Grilc, univ. dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: matjaz.grilc@gov.si

Tomaž Petek, univ. dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: tomaz.petek@gov.si

Aerolasersko skeniranje v arheologiji brez meja

Airborne laser scanning in archaeology without borders

izr. prof. dr. Žiga Kokalj

POVZETEK

Aerolasersko skeniranje (ALS, lidar) je v zadnjih dveh desetletjih močno spremenilo možnosti arheološkega raziskovanja pokrajine. Z uporabo podrobnih modelov višin in njihovih prikazov lahko prepoznavamo sledove človekove dejavnosti, ki so na terenu, optičnih posnetkih ali drugih podatkih daljinskega zaznavanja slabo vidni ali povsem skriti. Vendar danes osrednji problem arheološke uporabe ALS ni več predvsem pomanjkanje podatkov, temveč sposobnost, da iz vedno večjih količin podatkov pridobimo arheološko uporabno informacijo. Delni odgovor lahko ponudi strojno učenje.

V prispevku bomo obravnavali štiri vrste meja. Prva je meja vidnega, ki jo je ALS v veliki meri že premaknilo: arheološke strukture je mogoče zaznati tudi v gozdnatih, težko prehodnih in težko dostopnih okoljih. Druga je meja dostopnosti. Odprti podatki niso nujno tudi praktično uporabni podatki. Objavljen oblak točk lahko za raziskovalca še vedno pomeni terabajte podatkov, zahtevno in časovno zamudno obdelavo ter potrebo po specializiranem znanju. Za številne arheološke naloge so zato pomembnejši kakovostni modeli višin in analitični prikazi, pripravljeni za interpretacijo. Tretja je geografska meja. Arheološki pojav je lahko terminološko enak, njegov izraz v podatkih pa se med pokrajinami razlikuje zaradi reliefa, vegetacije, značilnosti zajema in obdelave podatkov. Posamezni pojavi se razlikujejo tudi v ohranjenosti, stopnji kasnejšega preoblikovanja in geografskem prekrivanju. Model strojnega učenja, ki dobro deluje na enem območju, zato ni nujno uspešen drugje. Za razvoj modelov, uporabnih v širšem evropskem prostoru, niso potrebne le večje količine učnih podatkov, temveč predvsem dovolj raznoliki in ustrezno strukturirani podatki iz različnih okolij. Četrta je meja medsebojne združljivosti. Nacionalne zbirke podatkov ALS se razlikujejo po karakteristikah in časih zajema, izdelanih modelih višin, zapisih in načinih dostopa. Nacionalna odprtost zato še ne pomeni čezmejne uporabnosti.

Strojno učenje je v tem okviru smiselno razumeti predvsem kot orodje za povečanje zmogljivosti arheologa. Njegova naloga ni nadomestiti proces interpretacije, temveč usmeriti pozornost na lokacije z največjim arheološkim potencialom. To je pomembno tako za raziskave kot za prostorsko načrtovanje, kjer je zgodnja informacija o možnih arheoloških ostalinah bistveno koristnejša od odkritja med gradnjo. Prihodnji razvoj zato zahteva podatkovni prostor, ki bo hkrati podpiral arheologa in algoritem ter omogočal delo prek geografskih, administrativnih in podatkovnih meja.

KLJUČNE BESEDE: aerolasersko skeniranje, strojno učenje, arheologija, čezmejni podatek, uporaben podatek

SUMMARY

Over the past two decades, airborne laser scanning (ALS, lidar) has radically transformed the possibilities for landscape archaeology. Using detailed elevation models and their visualisations, we can identify traces of human activity that are barely visible or completely hidden in the field, in aerial photographs or in other remote sensing data. However, the central challenge facing the archaeological application of ALS today is no longer primarily a

lack of data, but rather the ability to extract archaeologically useful information from ever-increasing volumes of data. Machine learning offers a partial solution to this problem.

In this presentation, we shall discuss four types of limitations. The first is the limitation of visibility, which ALS has already largely overcome: archaeological structures can be detected even in wooded impassable and hard-to-reach environments. The second is the limitation of accessibility. Open data are not necessarily practically useful data. A published point cloud may still represent terabytes of data for a researcher, requiring complex and time-consuming processing, as well as specialist knowledge. For many archaeological tasks, high-quality elevation models and analytical visualisations, ready for interpretation, are therefore more important. The third is the geographical boundary. An archaeological feature may be terminologically identical, yet its representation in the data varies between regions due to relief, vegetation and the characteristics of data acquisition and processing. Individual features also differ in terms of preservation, the extent of subsequent alteration and geographical overlap. A machine learning model that works well in one area is therefore not necessarily successful elsewhere. Developing models that are usable across the wider European area requires not only larger volumes of training data, but above all sufficiently diverse and appropriately structured data from different environments. The fourth limitation is that of interoperability. National ALS datasets differ in terms of their characteristics and acquisition dates, the elevation models produced, their formats and methods of access. National openness therefore does not yet imply cross-border usability.

In this context, machine learning should primarily be understood as a tool to enhance the archaeologist's capabilities. Its role is not to replace the process of interpretation, but to direct attention towards sites with the greatest archaeological potential. This is important both for research and for spatial planning, where early information on potential archaeological remains is far more useful than a discovery made during construction. Future development therefore requires a data space that will simultaneously support both the archaeologist and the algorithm, whilst enabling work across geographical, administrative and data boundaries.

KEY WORDS: airborne laser scanning, machine learning, archaeology, cross-border data, useful data

izr. prof. dr. Žiga Kokalj, univ. dipl. geogr.
Znanstvenoraziskovalni center Slovenske akademije znanosti in umetnosti, Podiplomska šola ZRC SAZU, Novi trg 2, 1000 Ljubljana
e-naslov: ziga.kokalj@zrc-sazu.si

Zemlja iz vesolja: napredni pristopi k spremljanju prostora s satelitskimi podatki

Earth from space: Advanced approaches for monitoring Earth's surface using satellite data

dr. Andreja Švab Lenarčič

POVZETEK

Satelitsko opazovanje Zemlje omogoča spremljanje številnih pojavov – od vremena, stanja ozračja in globalnih okoljskih sprememb do vegetacije, voda, premikov površja ter sprememb v prostoru. Prispevek predstavlja izbrane pristope in izkušnje Geodetske uprave pri uporabi satelitskih podatkov, ki jih razvijamo tudi v sodelovanju z drugimi institucijami v okviru skupnosti Geo Slovenija.

Eden konkretnih primerov takšnega sodelovanja je skupna uporaba komercialnih satelitskih posnetkov Planet. Skupno naročilo omogoča, da enoten vir podatkov in platformo uporablja več institucij javne uprave v različnih delovnih procesih. Ob tem se oblikuje skupnost uporabnikov, ki si izmenjuje izkušnje in dobre prakse ter sodeluje na skupnih izobraževanjih in delavnicah. Takšen pristop omogoča smotrnejše pridobivanje podatkov, predvsem pa krepi znanje in njihovo dejansko uporabo.

Pri spremljanju prostora ni vedno najpomembnejša najvišja prostorska ločljivost, temveč izbira pravega vira za pravi namen. PlanetScope omogoča pogosto in sistematično spremljanje celotnega ozemlja Slovenije, medtem ko je za izbrana manjša območja mogoče naročiti zelo visokoločljive posnetke SkySat. Tak pristop omogoča agilnejši odziv ob dogodkih ali zaznanih spremembah. Satelitski podatki pa niso omejeni le na optične podobe. Na Geodetski upravi podpiramo tudi uporabo tehnologije InSAR – točke kombinirane geodetske mreže 0. reda smo nadgradili s sipalci InSAR, ki zagotavljajo referenco za umeščanje satelitskih radarskih opazovanj v državni koordinatni sistem.

Nove možnosti prinaša umetna inteligenca. Sodobna orodja omogočajo, da uporabnik z navodilom v naravnem jeziku zahteva analizo izbranega območja skozi daljše časovno obdobje, sistem pa izvede analizo ter pripravi poročilo z ugotovitvami, grafi in slikami. Napredka pa ne razumemo zgolj tehnološko. Na Geodetski upravi v prakso postopoma uvajamo tudi celovitejši pristop k upravljanju satelitskih podatkov po devetih strateških usmeritvah okvira Združenih narodov IGIF. Poleg podatkov in tehnologije tako sistematično obravnavamo tudi upravljanje, pravni in finančni okvir, standarde, partnerstva, kompetence ter predvsem potrebe uporabnikov in vrednost, ki jo podatki ustvarjajo.

Prihodnji razvoj ni vezan na posamezen satelit ali ponudnika. Odprti smo za uporabo različnih evropskih, komercialnih in slovenskih satelitskih virov, kadar ti lahko izboljšajo naše procese. Cilj je različne vire opazovanja Zemlje povezovati med seboj ter z drugimi prostorskimi podatki in jih postopoma vključevati v geoprostorski dvojček Slovenije. Napredno spremljanje prostora tako ni le vprašanje vedno zmogljivejših tehnologij, temveč tudi sposobnosti povezati prave podatke, znanje in ljudi za pravi namen.

KLJUČNE BESEDE: satelitski podatki, opazovanje Zemlje, spremljanje prostora, interoperabilnost, umetna inteligenca, geoprostorski dvojček

SUMMARY

Satellite Earth observation enables the monitoring of a wide range of phenomena – from weather and global environmental change to vegetation, water, surface displacement and changes in the physical environment. This paper presents selected approaches and experiences of the Surveying and Mapping Authority of the Republic of Slovenia in the use of satellite data, also developed in cooperation with other institutions within the Geo Slovenia community.

One example is the shared use of commercial Planet satellite imagery. Joint procurement enables several public administration institutions to use a common data source and platform in different workflows, while a growing user community exchanges experience and good practices and participates in joint training and workshops. This approach supports more efficient data acquisition and strengthens knowledge and practical use.

Effective monitoring does not always require the highest spatial resolution, but rather the right data source for the right purpose. PlanetScope enables frequent and systematic monitoring of Slovenia, while very-high-resolution SkySat imagery can be commissioned for selected smaller areas, allowing a more agile response to events or detected changes. Satellite data are not limited to optical imagery: points of Slovenia's zero-order combined geodetic network have also been equipped with InSAR reflectors, providing a reference for integrating satellite radar observations into the national coordinate reference system.

Artificial intelligence brings new opportunities, enabling users to request analyses of selected areas over longer periods using natural-language instructions and receive reports with findings, graphs and images. At the same time, the Surveying and Mapping Authority is introducing a comprehensive approach to satellite data management based on the nine strategic pathways of the United Nations Integrated Geospatial Information Framework (UN-IGIF), addressing governance, legal and financial frameworks, standards, partnerships, competencies, user needs and value creation.

Future development is not tied to a single satellite or provider. Our goal is to combine European, commercial and Slovenian Earth observation sources with other geospatial data and gradually integrate them into Slovenia's geospatial digital twin. Advanced monitoring is therefore not only about increasingly powerful technologies, but about bringing together the right data, knowledge and people for the right purpose.

KEY WORDS: satellite data, Earth observation, spatial monitoring, interoperability, artificial intelligence, geospatial digital twin

dr. Andreja Švab Lenarčič, univ. dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: andreja.svab-lenarcic@gov.si

Praktična implementacija ocenjevanja kakovosti po ISO 19157 v državnih podatkovnih zbirkah in njen pomen pri avtomatizirani zaznavi prostorskih podatkov

Practical implementation of ISO 19157 quality evaluation in national spatial datasets and its significance for the automated detection of geospatial data

Primož Kete, dr. Andreja Švab Lenarčič, Katja Šušteršič

POVZETEK

Standard ISO 19157 predstavlja mednarodni okvir za sistematično opisovanje, merjenje in poročanje o kakovosti prostorskih podatkov. Kakovost pri tem ni izražena z eno samo vrednostjo, temveč z več elementi, med katerimi so popolnost, logična skladnost, položajna in tematska točnost ter časovna kakovost. Izhodišče za njeno ocenjevanje so jasno opredeljene zahteve in kriteriji, na podlagi katerih je mogoče kakovost podatkov meriti, dokumentirati in spremljati skozi njihov življenjski cikel.

Geodetska uprava Republike Slovenije je na podlagi standarda ISO 19157 ter rezultatov raziskovalnega projekta CRP 2023 V2-2387 razvijala praktičen pristop k celovitemu upravljanju kakovosti prostorskih podatkov. Pomemben cilj pri tem ni bila le kontrola kakovosti posameznih podatkovnih zbirk Geodetske uprave, temveč oblikovanje pristopa, ki ga je mogoče prenesti tudi na podatke drugih institucij in s tem postopoma vzpostavljati skupen okvir ocenjevanja kakovosti znotraj Geo Slovenije.

Takšen pristop je bil v okviru projekta GEO Akademija preizkušen skupaj s šestimi deležniki na 12 različnih podatkovnih slojih. Za posamezne sloje so bile glede na njihove specifikacije določene cenilke kakovosti, izvedene ocene ter pripravljena strukturirana poročila o kakovosti. S tem je bil teoretični okvir standarda prenesen v praktičen postopek, uporaben za različne vrste prostorskih podatkov in različne institucije.

Pristop je bil nadalje uporabljen v masovni produkciji 2,5D-poligonov in 3D-modelov stavb, kjer ocenjevanje kakovosti ni več le zaključna kontrola izdelka, temveč sestavni del produkcijskega procesa in podlaga za potrjevanje rezultatov. Izkušnje kažejo tudi pomen sodelovanja strokovnjakov, ki poznajo tehnične postopke, z vsebinskimi skrbniki posameznih vrst prostorskih podatkov.

Pomen sistematičnega in med institucijami primerljivega ocenjevanja kakovosti se povečuje z avtomatizacijo zajema, povezovanja in analiziranja prostorskih podatkov. Daljinsko zaznavanje, avtomatizirani algoritmi in umetna inteligenca omogočajo obdelavo vedno večjih količin podatkov iz različnih virov, zato postaja poznavanje njihove kakovosti, omejitev in primernosti za posamezen namen bistven del zanesljive uporabe podatkov. Skupen okvir kakovosti lahko tako predstavlja enega od temeljev prihodnje podatkovne infrastrukture Geo Slovenije ter omogoča bolj sledljivo, primerljivo in zaupanja vredno avtomatizirano uporabo prostorskih podatkov.

KLJUČNE BESEDE: ISO 19157, ocenjevanje kakovosti, avtomatizacija zajema prostorskih podatkov, državni topografski model, Geo Slovenija

SUMMARY

The ISO 19157 standard provides an international framework for the systematic description, measurement and reporting of geospatial data quality. Data quality is not represented by a single measure, but is described through a set of quality elements, including completeness, logical consistency, positional accuracy, thematic accuracy and temporal quality. The evaluation of these elements is based on clearly defined quality requirements and evaluation criteria, enabling the quality of geospatial data to be quantitatively assessed, documented and monitored throughout the data lifecycle.

Building on the ISO 19157 standard and the results of the research project CRP 2023 V2-2387, the Surveying and Mapping Authority of the Republic of Slovenia has been developing a practical approach to comprehensive geospatial data quality management. The objective of this work extends beyond quality control of individual datasets maintained by the Surveying and Mapping Authority. A key objective is to establish a transferable methodology that can also be applied to geospatial data managed by other institutions, thereby contributing to the gradual development of a common framework for quality assessment within the Geo Slovenia ecosystem.

The proposed approach was evaluated within the GEO Academy project in cooperation with six stakeholders and applied to 12 different geospatial datasets. For each dataset, quality measures were defined in accordance with the relevant data specifications. Quality evaluations were subsequently performed, and the results were documented in a structured quality report. This process demonstrated how the conceptual principles defined by ISO 19157 can be operationalised as a practical and repeatable procedure applicable to heterogeneous geospatial datasets and across institutional boundaries.

This approach was integrated into the large-scale production of 2.5D building polygon datasets and 3D building models, where quality assessment became an integral part of the production workflow rather than solely a final quality-control step. The experience highlighted the importance of collaboration between data production and domain experts in ensuring content quality and dataset validation.

As geospatial data acquisition and processing become increasingly automated through remote sensing, advanced algorithms and artificial intelligence, systematic and interoperable quality assessment is essential. Understanding data quality, uncertainty, limitations and fitness for purpose is fundamental to the reliable use of heterogeneous geospatial information. A harmonised quality framework across institutions could therefore become an important component of the future Geo Slovenia data infrastructure. Such a framework would support consistent quality assessment and documentation while improving traceability, comparability, transparency and confidence in the integration and use of geospatial data from multiple sources.

KEY WORDS: ISO 19157, quality evaluation, automation of geospatial data acquisition, national topographic model, Geo Slovenia

Primož Kete, univ. dipl. inž. geod.
Geodetski inštitut Slovenije, Jamova cesta 2, 1000 Ljubljana
e-naslov: primoz.kete@gis.si

dr. Andreja Švab Lenarčič, univ. dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: andreja.svab-lenarcic@gov.si

Katja Šušteršič, univ. dipl. inž. geod.
Flycom Technologies, Celovška cesta 520, 1210 Ljubljana
e-naslov: katja.sustersic@flycom.si

Geodetski podatki kot podpora multimodalni mobilnosti oseb z različnimi invalidnostmi

Geodetic data as a support for multimodal mobility of persons with various disabilities

mag. Roman Rener, Marina Lovrić, Jani Demšar

POVZETEK

Želja vsake osebe z invalidnostjo je, da se v prostoru giblje varno in samostojno. Geodetski podatki so pomemben vir vhodnih podatkov za varno mobilnost oseb z invalidnostmi in starejših. Na našem inštitutu vsebine, povezane z multimodalno mobilnostjo in dostopnostjo grajenega okolja za ranljive skupine, razvijamo že štiri desetletja. Razvili smo celotno metodologijo in standarde za dostopnost urbanega okolja mest in naselij za pet ranljivih skupin: gibalno ovirane, slepe in slabovidne, gluhe in naglušne, starejše in osebe z motnjami v duševnem razvoju. Podpisali smo dogovor o sodelovanju že s 150 občinami, pri katerih izvajamo zajem podatkov skladno s predhodno omenjenimi standardi.

V predstavitvi bomo poleg osnovnih značilnosti mobilnosti ranljivih skupin predstavili primer dobre prakse, ki prikazuje vsakodnevno pot gibalno ovirane osebe skozi Ljubljano ter raziskuje odnos med mestnim prostorom, dostopnostjo ter kartografskim prikazom prostora. Pot, ki smo jo izbrali, omogoča uporabo različnih podatkovnih slojev Geodetske uprave RS kakor tudi drugih prostorskih podatkov, s katerimi smo omogočili Aljoši (osebi na invalidskem vozičku), da je samostojno opravila pot. Poseben poudarek je namenjen multimodalni mobilnosti. Ta pomeni, da posameznik pri opravljanju poti uporablja in med seboj povezuje različne načine mobilnosti. Za izvedbo testiranja so bile pridobljene kartografske podlage iz spletnega portala Javnega vpogleda geodetskih podatkov ter drugih javno dostopnih prostorskih baz podatkov. Pomemben vir predstavljajo tudi podatki Agencije Republike Slovenije za okolje (ARSO).

Predhodno našteti geodetski podatki imajo pri tem poseben pomen, saj podpirajo celotno načrtovanje poti, varno in samostojno mobilnost na tej poti, zanesljivo orientacijo v prostoru in razpoznavanje ovir.

KLJUČNE BESEDE: multimodalna mobilnost, osebe z invalidnostmi, geodetski podatki, dostopnost grajenega okolja

SUMMARY

Every person with a disability wishes to move around safely and independently. Geospatial data are an important input source for the safe mobility of persons with disabilities and elderly persons. At our institute, we have been developing content related to multimodal mobility and the accessibility of the built environment for vulnerable groups for four decades. We have developed a comprehensive methodology and standards for the accessibility of the built environment in towns and settlements for five vulnerable groups: people with mobility impairments, the blind and visually impaired, the deaf and hard of hearing, elderly persons and people with intellectual disabilities. We have already signed cooperation agreements with 150 local authorities, for which we are carrying out data collection in accordance with the standards.

In this presentation, alongside the basic characteristics of mobility among vulnerable groups, we will present an example of good practice that illustrates the daily journey of a person with a mobility impairment through Ljubljana and explores the relationship between urban space, accessibility and the cartographic representation of space. The route we selected allows us to use various data layers from the Surveying and Mapping Authority of the Republic of Slovenia, as well as other spatial data, to enable Aljoša (a person in a wheelchair) to complete the journey independently. Emphasis is placed on multimodal mobility. This means that an individual uses and combines different modes of transport whilst travelling. For testing, cartographic data were obtained from the Public Access to Geodetic Data portal and other publicly available spatial databases. Data from the Slovenian Environment Agency (ARSO) also represent an important source.

The geodetic data listed above are particularly important in this context, as they support comprehensive route planning, safe and independent mobility along the route, reliable spatial orientation and obstacle identification.

KEY WORDS: multimodal mobility, persons with disabilities, geospatial data, accessibility of the built environment

mag. Roman Rener, univ. dipl. inž. geod.
Geodetski inštitut Slovenije, Jamova cesta 2, 1000 Ljubljana
e-naslov: roman.rener@gis.si

Jani Demšar, mag. obl.
Geodetski inštitut Slovenije, Jamova cesta 2, 1000 Ljubljana
e-naslov: jani.demsar@gis.si

Marina Lovrić, mag. inž. arh.
Geodetski inštitut Slovenije, Jamova cesta 2, 1000 Ljubljana
e-naslov: marina.lovric@gis.si

Kataster nepremičnin: izvedba in izzivi

Real estate cadastre: Implementation and challenges

mag. Ema Pogorelčnik, Marko Rotar, Jaka Urbanc,
Andrej Hudoklin, Dominik Zupan

POVZETEK

Izvedba postopkov po Zakonu o katastru nepremičnin se je tekom štirih let in pol že dodobra utekla. Geodetska podjetja oddajajo elaborate, geodetska uprava sproti v zakonsko predvidenih rokih izvaja upravni del in podatke potrjuje v katastru nepremičnin. Pričeli smo s ponovno izvedbo novih izmer po novi zakonodaji, izvajamo lokacijske izboljšave glede na potrebe in predloge, ki jih prejmemo. Sproti izvajamo tudi evidentiranje podatkov z zahtevami brez elaborata, ki jih ni malo. V teh letih smo tudi novelirali Zakon o katastru nepremičnin in osnovni Pravilnik o vodenju podatkov katastra nepremičnin.

Na področju Registra prostorskih enot smo podatke v nov informacijski sistem migrirali leta 2024, podatki se aktivno uporabljajo in spreminjajo za različne namene, v zadnjem času zopet bolj aktivno za namene volitev referendumov. Na področju podatkov Zbirnega katastra gospodarske javne infrastrukture smo posodobili informacijski sistem, ga povezali s katastrom nepremičnin in tudi posodobili ter pridobili vrsto podatkov. Na področju evidentiranja bonitet zemljišč smo vzpostavili novo razvojno okolje analitike za izboljšavo podatkov, uporabniki pa lahko uporabljajo mobilno aplikacijo *mBonitete* za podajanje predlogov posebnih vplivov. Posebno skrb smo posvetili obvladovanju kakovosti podatkov, od posebnih analiz do aktiviranja odprave napak, za katere vemo, da še vedno obstajajo v bazi.

Navkljub veliki količini opravljenega dela pa izzivov za prihodnje ne manjka. Predvsem smer razvoja vseh nepremičninskih in ostalih evidenc v prihodnje. Kataster nepremičnin in zbirni kataster gospodarske javne infrastrukture bo potrebno povezati z uporabo rezultatov 3D-modeliranja tako stavb kot gospodarsko inženirskih objektov, večji izzivi razvoja katastra bodo tudi na področju vključevanja AI v informacijske sisteme kot tudi v postopke evidentiranja.

V letih od 2026 do 2028 nameravamo kataster in druge nepremičninske evidence razvijati tudi v okviru ciljnih raziskovalnih projektov na temo vzpostavitve sodobne in integrirane zemljiške administracije kot podlage za strateški prostorski razvoj, upravljanje prostora in javne politike. Naloga je usmerjena v pripravo strokovnih razvojnih podlag za nadaljnji razvoj oziroma nadgradnjo sistema zemljiške administracije v Republiki Sloveniji, kjer ima kataster nepremičnin osrednjo vlogo.

KLJUČNE BESEDE: kataster, nepremičnine, evidentiranje, izzivi

SUMMARY

The Real Estate Cadastre Act and the implementation of procedures under the new legislation have now been well established over the course of four and a half years. Surveying companies are submitting their reports, whilst the Surveying and Mapping Authority is carrying out the administrative work within the statutory time limits and validating the data in the real estate cadastre. We have begun performing new surveys in accordance with the new legislation and are implementing location-based improvements in line with the needs and

proposals we receive. We are also, on an ongoing basis, recording data based on numerous requests without a survey report. Over the years, we have also amended the Real Estate Cadastre Act and the basic Regulations on the Management of Real Estate Cadastre Data.

In the area of the register of spatial units, we migrated the data to a new information system in 2024. The data are actively used and modified for various purposes and recently has once again been used more actively for the purposes of elections and referendums. In the area of the Public Infrastructure Cadastre, we have updated the information system, linked it to the real estate cadastre and also updated and acquired a range of data.

In the area of capability evaluation of land registration, we have established a new analytics development environment to improve the data, whilst users can utilise the *mBonitete* mobile app to submit proposals regarding specific impacts. We have paid particular attention to data quality management, ranging from specific analyses to initiating the rectification of errors which we know still exist in the database.

Despite the significant amount of work completed, there is no shortage of challenges for the future. The main challenge concerns the future direction of development of property and other registers. The Real Estate Cadastre and the Public Infrastructure Cadastre will need to be integrated using the results of 3D modelling of both buildings and civil engineering structures. Major challenges in the development of the real estate cadastre will also arise in the area of integrating AI into information systems as well as into registration procedures.

Between 2026 and 2028, the aim is to develop the cadastre and other property registers as part of targeted research projects focused on establishing a modern and integrated land administration system as a foundation for strategic spatial development, spatial management and public policy. The task is focused on preparing expert development frameworks for the further development or upgrading of the land administration system in the Republic of Slovenia, in which the real estate cadastre plays a central role.

KEY WORDS: cadastre, real estate, register, challenges

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mag. Ema Pogorelčnik, univ. dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: ema.pogorelcnik@gov.si

Marko Rotar, dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: marko.rotar@gov.si

Jaka Urbanc
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: jaka.urbanc@gov.si

Andrej Hudoklin, dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: andrej.hudoklin@gov.si

Dominik Zupan, dipl. inž. geod.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: dominik.zupan@gov.si

Evidenca stavbnih zemljišč v praksi: podatkovna podlaga za izvajanje zemljiške politike

The register of building land in practice: A data basis for implementing land policy

Ajda Kafol Stojanović, mag. Matija Kralj, Petra Kurnik

POVZETEK

Evidenca stavbnih zemljišč (ESZ) je prostorska evidenca, ki vsebuje podatke o pozidanih in nepozidanih stavbnih zemljiščih. Za nepozidana stavbna zemljišča se v ESZ vodijo tudi podatki o razvojnih stopnjah, ki izkazujejo pripravljenost zemljišč za dejansko aktivacijo oziroma gradnjo. Iz razvojnih stopenj je razvidno, katere ovire je treba odpraviti za aktivacijo posameznega zemljišča, na primer sprejeti prostorski akt, zagotoviti komunalno opremo ali izvesti parcelno oziroma lastniško preureditev.

ESZ torej omogoča celovit pregled nad stanjem in razvojnim potencialom stavbnih zemljišč ter predstavlja pomembno podatkovno podlago za prostorsko načrtovanje, načrtovanje komunalne opreme, izvajanje ukrepov zemljiške politike, vrednotenje stavbnih zemljišč in spremljanje prostorskega razvoja. Podatki so uporabni tudi pri pripravi načrta preskrbe in upravljanja zemljišč, usmerjanju investicij ter odmeri dajatev, povezanih s stavbnimi zemljišči. Lastnikom in investitorjem zagotavljajo preglednejše informacije o stanju zemljišč in aktivnostih, potrebnih pred gradnjo.

Občine v letu 2026 podatke ESZ intenzivno vzpostavljajo, prve med njimi pa jih že uporabljajo pri izvajanju zemljiške politike. Eden od ukrepov varovanja zemljišč, ki je posebej pomemben za geodetsko stroko, je soglasje za spreminjanje meje parcele po ZUreP-3. Soglasje občine je treba pridobiti pri spreminjanju mej gradbenih parcel stavb, mej pripadajočih zemljišč stavb, evidentiranih v ESZ, in mej parcel na območjih, ki jih občina posebej določi z odlokom (196. člen ZUreP-3). Namen ukrepa je preprečevati nastajanje parcelne strukture, ki ne bi bila skladna s prostorskim izvedbenim aktom ali bi oteževala smotrno rabo in razvoj zemljišč.

V predavanju bodo predstavljeni izbrani načini uporabe podatkov ESZ s poudarkom na vsebinah, pomembnih za geodetsko stroko. Podrobneje bodo obravnavana pravila za ugotavljanje, kdaj je treba pri katastrskih postopkih pridobiti soglasje občine, s posebnim poudarkom na spreminjanju zunanjega oboda pripadajočega zemljišča stavbe. Predavanje bo tako osvetlilo neposreden vpliv vzpostavitve ESZ na izvajanje geodetskih postopkov ter povezanost katastra nepremičnin, prostorskega načrtovanja in zemljiške politike.

KLJUČNE BESEDE: evidenca stavbnih zemljišč, zemljiška politika, soglasje za spreminjanje mej, pozidana zemljišča, nepozidana stavbna zemljišča

SUMMARY

The Register of Building Land (ESZ) is a spatial register containing data on built-up and undeveloped building land. For undeveloped building land, ESZ also records development stages indicating the readiness of land for activation or construction. These stages reveal which obstacles must be addressed before a particular site can be activated, such as adopting a spatial planning act, providing municipal infrastructure or carrying out parcel or ownership restructuring.

ESZ provides a comprehensive overview of the current state and development potential of building land. It constitutes an important data basis for spatial planning, municipal infrastructure planning, the implementation of land policy measures, building land valuation and the monitoring of spatial development. The data are also useful for preparing land supply and management plans, guiding investments and assessing levies related to building land. They provide landowners and investors with clearer information about the status of land and the activities required before construction can begin.

In 2026, municipalities are actively establishing their ESZ datasets, and some have already begun using them to implement land policy. One of the land protection measures of particular relevance to the surveying profession is the requirement under the Slovenian Spatial Planning Act (ZUreP-3) to obtain consent for altering plot boundaries. Such consent must be obtained when altering the boundaries of building plots, the boundaries of the appurtenant land of buildings recorded in ESZ and parcel boundaries within areas specifically designated by a municipality through an ordinance (Article 196 of ZUreP-3). The purpose of this measure is to prevent the creation of a parcel structure that is inconsistent with the applicable spatial implementation act or could hinder the efficient use and development of land.

The presentation will introduce selected applications of ESZ data, focusing on topics relevant to the surveying profession. It will examine in greater detail the rules for determining when municipal consent must be obtained in cadastral procedures, with particular emphasis on changes to the outer perimeter of the appurtenant land of a building. The presentation will thus highlight the direct impact of establishing ESZ on cadastral procedures and the links between the real estate cadastre, spatial planning and land policy.

KEY WORDS: Register of Building Land, land policy, consent for altering plot boundaries, built-up land, undeveloped building land

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Ajda Kafol Stojanović, mag. prost. načrt.
Geodetski inštitut Slovenije, Jamova cesta 2, 1000 Ljubljana
e-naslov: ajda.kafol@gis.si

mag. Matija Kralj, univ. dipl. inž. geod.
Ministrstvo za okolje in prostor, Direktorat za prostor, graditev in stanovanja, Dunajska cesta 48, 1000 Ljubljana
e-naslov: matija.kralj@gov.si

Petra Kurnik, dipl. geog. in dipl. ital. jez. in knj.
Ministrstvo za okolje in prostor, Direktorat za prostor, graditev in stanovanja, Dunajska cesta 48, 1000 Ljubljana
e-naslov: petra.kurnik@gov.si

Prenova metodologij ocenjevanja vrednosti nepremičnin v javno korist

Enhancement of real estate valuation methodologies for public sector acquisitions

Valentina Brečko Čebela

POVZETEK

Določanje vrednosti nepremičnin za potrebe javnih odkupov, razlastitev ter upravljanja nepremičnega premoženja države in lokalnih skupnosti v Sloveniji že vrsto let spremljajo enaki izzivi: različni metodološki pristopi, neenotne cenitve, različna obravnava primerljivih primerov ter dolgotrajni postopki. Čeprav so bile prve sistemske pobude za poenotenje področja vzpostavljene že pred več kot desetletjem, do danes še ni prišlo do njihove celovite uveljavitve v praksi.

Pomemben premik k poenotenju področja je bil storjen leta 2015 z razvojem metodologij ocenjevanja vrednosti nepremičnin za potrebe prisilnih odkupov in določanja odškodnin pri gradnji gospodarske javne infrastrukture. Metodologije, pripravljene v sodelovanju slovenskih in švedskih strokovnjakov, so predstavljale prvo celovito sistemsko podlago za določanje vrednosti nepremičnin, pravic in škod. Temeljile so na podatkih in modelih takratnega sistema množičnega vrednotenja nepremičnin, prilagojenih za potrebe individualnega ocenjevanja. Čeprav je Vlada Republike Slovenije metodologije potrdila kot ustrezno strokovno podlago, njihova uporaba ni bila normativno urejena, zato v praksi ni prišlo do enotne uporabe metodoloških pristopov.

V naslednjih letih so bili prenovljeni modeli množičnega vrednotenja nepremičnin in podatkovne podlage, kar je zahtevalo posodobitev metodologij. Hkrati so se vse pogosteje odpirala vprašanja gospodarnosti ravnanja z nepremičnim premoženjem države in občin, kar je pokazalo potrebo po enotnih strokovnih podlagah tudi za pridobivanje, razpolaganje in upravljanje javnega nepremičnega premoženja izven postopkov razlastitev.

Leta 2026 je bil zaključen projekt »Nadgradnja in prenova metodologij ocenjevanja vrednosti za namene odkupov nepremičnin v javno korist ter upravljanja z nepremičninami države in lokalnih skupnosti«, katerega cilj je bil posodobiti metodologije iz leta 2015, jih prilagoditi novim modelom množičnega vrednotenja nepremičnin ter razširiti njihovo uporabo na področje pridobivanja, razpolaganja in upravljanja javnega nepremičnega premoženja.

Osrednje konceptualno izhodišče prenovljenih metodologij je povezovanje modelnih vrednosti iz sistema množičnega vrednotenja in individualnega ocenjevanja. Modelna vrednost predstavlja izhodišče za ocenjevanje, ki ga ocenjevalec na podlagi dejanskega stanja nepremičnine in metodološko določenih prilagoditev nadgradi do ocene tržne vrednosti. Pri razlastitvah in drugih posegih v lastninsko pravico pa tržna vrednost praviloma ne predstavlja končne odškodnine, saj je treba upoštevati tudi druge posledice posega in z njimi povezane škode, katerih vrednotenje prav tako sistematično urejajo prenovljene metodologije.

Prispevek predstavlja razvoj področja, ključne sistemske izzive, koncept prenovljenih metodologij ter njihov pomen za vzpostavitev enotnega, preglednega in strokovno preverljivega sistema ocenjevanja vrednosti nepremičnin za javne namene.

KLJUČNE BESEDE: ocenjevanje vrednosti nepremičnin, razlastitev, javna korist, množično vrednotenje nepremičnin, odškodnine, metodologije

SUMMARY

The determination of real estate values for public acquisitions, expropriations and the management of real property assets owned by the state and local communities in Slovenia has long been characterised by recurring challenges, including differing methodological approaches, inconsistent valuations, unequal treatment of comparable cases and lengthy procedures. Although the first systematic initiatives aimed at harmonising the field were launched more than a decade ago, they have not yet been fully implemented in practice.

A significant step towards greater consistency was taken in 2015 with the development of methodologies for real estate valuation for the purposes of compulsory acquisitions and compensation assessment related to the construction of public utility infrastructure. Developed through collaboration between Slovenian and Swedish valuation experts, these methodologies represented the first comprehensive and systematic framework for the valuation of real property, rights and damages. They were based on the data and models of the then existing mass appraisal system, adapted for the purposes of individual property valuation. Although the Government of the Republic of Slovenia endorsed the methodologies as an appropriate professional basis, their application was not formally regulated and therefore did not result in the uniform use of valuation approaches in practice.

In the years that followed, the models of mass real estate valuation and the underlying data infrastructure were substantially modernised, creating a need to update the methodologies. At the same time, increasing attention was given to the efficiency and economy of managing state and municipal real property assets, highlighting the need for uniform professional guidelines not only for expropriation procedures but also for the acquisition, disposal and management of public real estate assets.

In 2026, the project Upgrade and Revision of Valuation Methodologies for Public Interest Property Acquisitions and the Management of State and Local Government Real Estate Assets was completed. Its objective was to modernise the 2015 methodologies, adapt them to the new mass appraisal models and expand their application to the broader field of public real estate asset management.

The central concept of the revised methodologies is the integration of model values derived from the mass appraisal system with individual valuation procedures. The model value serves as the starting point for valuation and is adjusted by the valuer based on the actual characteristics of the property and methodology-defined adjustments to arrive at an estimate of market value. In expropriation and other interventions affecting property rights, however, market value does not necessarily represent the final compensation, as additional impacts and related damages must also be considered. The valuation of such damages is likewise systematically addressed within the revised methodologies.

The paper presents the development of the field, the key systemic challenges, the concept of the revised methodologies and their significance for establishing a uniform, transparent and professionally verifiable system for real estate valuation for public purposes.

KEY WORDS: real estate valuation, expropriation, public interest, mass real estate valuation, compensation, valuation methodologies

Valentina Brečko Čebela, dipl. inž. grad.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: valentina.brecko-cebela@gov.si

Analiza stanja lastništva in vrednosti nepremičnin v lasti pravnih oseb

Analysis of the ownership status and value of real estate owned by legal entities

Kristina Perko, Maja Ristić

POVZETEK

Republika Slovenija, lokalne skupnosti in druge pravne osebe upravljajo obsežen fond nepremičnega premoženja. Za njegovo učinkovito upravljanje so potrebni zanesljivi podatki o nepremičninah, njihovih lastnikih in vrednosti. Pri tem je za pripravo analiz posebej pomembna možnost enoznačne identifikacije lastnika ter povezave nepremičnine z ustreznim pravnim oziroma upravljavskim subjektom.

Evidenca vrednotenja predstavlja pomembno podatkovno podlago za tovrstne analize, saj so v njej povezani podatki o parcelah, stavbah in delih stavb, njihovih lastnostih, lastnikih ter posplošenih vrednostih nepremičnin. Pri pripravi analize se je pokazalo, da ključni izziv ni predvsem pridobivanje in povezovanje podatkov o posameznih nepremičninah iz različnih evidenc, temveč ustrezna interpretacija in klasifikacija podatkov o njihovih lastnikih. Podatka o lastniku namreč ni mogoče vedno neposredno uporabiti za določitev njegovega dejanskega pravnega oziroma upravljavskega statusa. Poleg neposredno prepoznavnih lastnikov, kot so Republika Slovenija in občine z matičnimi številkami, se v podatkih pojavljajo tudi pravne osebe brez matičnih številk, vpisi javnega dobra, družbene lastnine ter drugi vpisi, ki jih ni mogoče neposredno povezati z danes obstoječimi poslovnimi subjekti. Takšna raznolikost načinov evidentiranja lastništva otežuje avtomatizirano analizo in zahteva uporabo dodatnih podatkovnih virov ter vsebinsko presojo posameznih skupin lastnikov.

Za določitev tipa lastnika so bili poleg podatkov evidence vrednotenja uporabljeni podatki Poslovnega registra Slovenije, Registra proračunskih uporabnikov, podatki o pravnoorganizacijskih oblikah, ustanoviteljih in dejavnostih ter določbe relevantne zakonodaje.

Namen analize je bil razviti metodološki pristop za enotno identifikacijo in klasifikacijo različnih oblik lastništva ter na tej podlagi pripraviti prostorski in vrednostni pregled nepremičnin v lasti pravnih oseb. Poseben poudarek je bil namenjen prepoznavanju nepremičnin, pri katerih način evidentiranja lastnika zahteva dodatno preverjanje oziroma ureditev podatkov o lastništvu in upravljavstvu javnega nepremičnega premoženja.

Na podlagi razvite metodologije je bila pripravljena analiza lastništva in vrednosti nepremičnin ter razviti prostorski in atributni pregledovalniki za nadaljnje preverjanje podatkov. V nabor nepremičnin, pri katerih podatki o lastništvu oziroma upravljavstvu zahtevajo dodatno preverjanje oziroma ureditev, je bilo vključenih približno 186.000 parcel s skupno posplošeno vrednostjo okoli 2,1 milijarde EUR ter približno 59.000 delov stavb s skupno posplošeno vrednostjo okoli 7,3 milijarde EUR.

Prispevek predstavlja metodološki pristop, rezultate analize in možnosti uporabe razvitih pregledovalnikov pri nadaljnjem preverjanju ter urejanju podatkov o lastništvu in upravljanju nepremičnega premoženja.

KLJUČNE BESEDE: evidenca vrednotenja nepremičnin, javno nepremično premoženje, lastništvo, upravljavstvo, klasifikacija lastnikov, množično vrednotenje nepremičnin

SUMMARY

The Republic of Slovenia, local communities and other legal entities manage an extensive real estate portfolio. Reliable data on real estate, its owners and its value are essential for its effective management. For the preparation of such analyses, the ability to uniquely identify the owner and to link a property to the relevant legal entity or managing authority is of particular importance.

The Real Estate Valuation Register provides an important data basis for such analyses, as it integrates data on parcels, buildings and parts of buildings, their characteristics, owners and generalised real estate values. The analysis showed that the main challenge was not primarily the acquisition and integration of data on individual properties from different registers, but rather the appropriate interpretation and classification of data on their owners. Data on the owner cannot always be directly used to determine the owner's actual legal or management status. In addition to directly identifiable owners, such as the Republic of Slovenia and municipalities with registration numbers, the data also include legal entities without registration numbers, entries relating to public good and socially owned property, as well as other entries that cannot be directly linked to currently existing business entities. Such diversity in the recording of ownership complicates automated analysis and requires the use of additional data sources and substantive assessment of individual groups of owners.

In addition to data from the Real Estate Valuation Register, data from the Slovenian Business Register, the Register of Budget Users, data on legal organisational forms, founders and activities, as well as relevant legislation, were used to determine the type of owner.

The purpose of the analysis was to develop a methodological approach for the uniform identification and classification of different forms of ownership and, on this basis, to prepare a spatial and value-based overview of real estate owned by legal entities. Particular attention was paid to identifying properties for which the manner in which the owner is recorded requires additional verification or improvement of ownership and management data relating to public real estate assets.

Based on the developed methodology, an analysis of the ownership and value of real estate was prepared, together with spatial and attribute-based viewers for further data verification. The group of properties for which ownership or management data require additional verification or improvement includes approximately 186,000 parcels with a total generalised value of around EUR 2.1 billion and approximately 59,000 parts of buildings with a total generalised value of around EUR 7.3 billion.

The paper presents the methodological approach, the results of the analysis and the potential use of the developed viewers for further verification and improvement of ownership and management data relating to real estate assets.

KEY WORDS: Real Estate Valuation Records, public real estate assets, ownership, property management, owner classification, mass real estate valuation

Kristina Perko, mag. posl. ved.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: kristina.perko@gov.si

Maja Ristić, mag. geol.
Geodetska uprava Republike Slovenije, Zemljemerska ulica 12, 1000 Ljubljana
e-naslov: maja.ristic@gov.si

Odkup zemljišč in ureditev služnosti za GJI

Land acquisition and establishment of servitudes for public utility infrastructure

mag. Toni Levičnik

POVZETEK

Gradnja in vzdrževanje gospodarske javne infrastrukture sta tesno povezana z urejanjem zemljiškopravnih razmerij. Odkup zemljišč in ustanavljanje služnostnih pravic predstavljata pomemben del priprave in izvedbe infrastrukturnih projektov, saj omogočata zakonito umeščanje objektov v prostor ter njihovo varno in nemoteno obratovanje.

Predavanje bo predstavilo vlogo geodetske stroke pri pridobivanju zemljišč in urejanju služnosti za potrebe plinovodov, elektroenergetskih vodov, cestne infrastrukture ter drugih objektov gospodarske javne infrastrukture. Poseben poudarek bo namenjen praktičnim izkušnjam pri sodelovanju z lastniki zemljišč, pripravi geodetskih podlag, izvajanju terenskih aktivnosti ter usklajevanju različnih interesov v procesu pridobivanja pravic na nepremičninah.

Predstavljeni bodo ključni koraki od načrtovanja trase in identifikacije prizadetih nepremičnin do sklepanja pravnih poslov, določanja odškodnin in vpisa stvarnih pravic v zemljiško knjigo. Obravnavani bodo tudi najpogostejši izzivi, s katerimi se srečujejo investitorji, geodeti in lastniki zemljišč, ter dobre prakse za učinkovito in sporazumno urejanje zemljiškopravnih razmerij.

Prispevek opozarja na pomen pravočasnega in strokovnega urejanja zemljiških zadev, ki pomembno vpliva na uspešnost, časovnico in stroške infrastrukturnih projektov. Predavanje je namenjeno geodetskim strokovnjakom, investitorjem, projektantom ter vsem, ki sodelujejo pri načrtovanju in izvajanju projektov gospodarske javne infrastrukture.

KLJUČNE BESEDE: nepremičnine, gospodarska javna infrastruktura, praktične izkušnje

SUMMARY

The construction and maintenance of public utility infrastructure are closely linked to the regulation of land-use rights. Land acquisition and the establishment of easements form a significant part of the preparation and implementation of infrastructure projects, as they enable the lawful siting of facilities and their safe and uninterrupted operation.

The lecture will present the role of the surveying profession in land acquisition and the establishment of easements for the purposes of gas pipelines, power lines, road infrastructure and other public utility infrastructure. Particular emphasis will be placed on practical experience in liaising with landowners, preparing surveying data, carrying out fieldwork and reconciling various interests in the process of acquiring rights over property.

The key steps will be presented, from route planning and the identification of affected properties to the conclusion of legal transactions, the determination of compensation and the registration of rights in rem in the land register. The presentation will also address the most common challenges faced by investors, surveyors and landowners, as well as best practices for the effective and amicable resolution of land-related legal matters.

The paper highlights the importance of the timely and professional resolution of land-related matters, which significantly affects the success, timeline and costs of infrastructure projects.

The lecture is aimed at surveying professionals, investors, designers and all those involved in the planning and implementation of public utility infrastructure projects.

KEY WORDS: property, public utility infrastructure, practical experience

mag. Toni Levičnik, univ. dipl. org., inž. geod.
Plinovodi, d. o. o., Cesta Ljubljanske brigade 11b, p. p. 3720, 1001 Ljubljana, Slovenija
e-naslov: toni.levicnik@plinovodi.si

Analiza upravne urejenosti objektov

Analysis of the administrative compliance of infrastructure

Nejc Krašovec in Aljaž Peklaj

POVZETEK

Na območju Slovenije je še vedno veliko objektov gospodarske javne infrastrukture (GJI) in cest, ki niso ustrezno pravno urejeni. Ti objekti pogosto potekajo po zasebnih zemljiščih, kjer upravljalec ni lastnik zemljišča, hkrati pa v zemljiški knjigi ni vpisanih ustreznih služnosti ali drugih stvarnih pravic, ki bi upravljalcu zagotavljale pravno podlago za obstoj in vzdrževanje infrastrukture.

Stanje izhaja iz več virov. V določenih primerih so podjetja oziroma upravljalci v preteklosti od lastnikov zemljišč sicer pridobili soglasja za gradnjo infrastrukture, vendar ta soglasja niso formalno vpisana v javne evidence – zato pravna podlaga na papirju obstaja, v zemljiški knjigi pa ni razvidna. V drugih primerih soglasij v preteklosti sploh niso pridobivali, kar odpira vprašanja lastninskopravnih razmerij.

V predstavitvi bomo osvetlili obseg problematike neurejenih razmerij med infrastrukturo in zasebnimi zemljišči ter predstavili konkretne primere iz prakse. Prikazali bomo tudi obstoječe pristope k reševanju te problematike, pri katerih je država sistemsko uredila razmerja predvsem na področju državne cestne infrastrukture, medtem ko področje GJI ostaja pretežno neurejeno in zahteva nadaljnje sistemske rešitve.

KLJUČNE BESEDE: gospodarska javna infrastruktura, upravljanje, služnosti

SUMMARY

Across Slovenia, many public utility infrastructure facilities and roads remain without a proper legal basis. These facilities often run across privately owned land where the operator is not the landowner, and no easements or other rights in rem are registered in the Land Register that would give the operator a legal basis for the infrastructure's existence and maintenance.

The situation has several causes. In some cases, companies or operators did obtain consent from landowners to build the infrastructure, but these consents were never formally entered into public records. As a result, a legal basis exists on paper but is not visible in the Land Register. In other cases, no consent was ever obtained, which raises questions about property rights.

In this presentation, we will outline the extent of unresolved relationships between infrastructure and private land and present concrete examples from practice. We will also present existing approaches to resolving the issue. The state has systematically settled these relationships mainly for national road infrastructure, while the public utility infrastructure sector remains largely unresolved and requires further systemic solutions.

KEY WORDS: public utility infrastructure, property management, obligation

Nejc Krašovec, mag. inž. geod. in geoinf.
LGB, d. o. o., Ukmarjeva ulica 4, 1000 Ljubljana in
GIZ-GI, Gospodarsko interesno združenje geodetskih izvajalcev, Jamova cesta 2, 1000 Ljubljana
e-naslov: nejc.krasovec@lgb.si

Aljaž Peklaj, mag. inž. geod. in geoinf.
LUZ, d. o. o., Verovškova ulica 64, 1000 Ljubljana in
GIZ-GI, Gospodarsko interesno združenje geodetskih izvajalcev, Jamova cesta 2, 1000 Ljubljana
e-naslov: aljaz.peklaj@luz.si

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