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CAN EVAPOTRANSPIRATION BE CONSIDERED AN ADDITIONAL INDICATOR FOR UNDERSTANDING THE CHANGED LANDSCAPE IDENTITY OF THE CLASSIC KARST?

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ABSTRACT

Evapotranspiration (ET) change is one of the most obvious ecohydrological effects of land use or vegetation cover change. In this regard, the landscape change process was initially observed by determining the fractional green vegetation cover difference between two time windows over a span of 12 years (2002 – 2014), followed by an estimation of the June mean daily actual evapotranspiration change within the Karst area in Slovenia, based on LANDSAT satellite imagery. Most of the study area has faced a clear gain in ET (74%), which perfectly matches the increase in scrub encroachment and forest progression. Furthermore, many surfaces with an ET rate decrease were also identified in the category of persistent forest land use mainly in the eastern part of the study area (76%), a finding which can be explained by the severe sleet event during the winter of 2014. It can be concluded that the estimated ET change rate can be an important complementary indicator for assessing the landscape change process from a more functional perspective.

Keywords: classic Karst, evapotranspiration, landscape change, land use, NDVI (normalized difference vegetation index)

PUÒ L'EVAPOTRASPIRAZIONE ESSERE CONSIDERATA UN NUOVO INDICATORE PER CAPIRE L'IDENTITÀ MUTATA DEL PAESAGGIO DEL CARSO CLASSICO?

SINTESI

Il cambiamento legato all'evapotraspirazione (ET) è uno dei più evidenti effetti eco-idrologici abbinati all'uso del suolo o alla modifica della copertura vegetazionale. In tale luce, il processo di cambiamento del paesaggio è stato inizialmente osservato determinando la differenza frazionaria della copertura vegetale verde tra due finestre temporali in un intervallo pari a dodici anni (2002 - 2014), seguita da una stima della media giornaliera del cambiamento evapotraspirazione reale nel mese di giugno all'interno della zona carsica in Slovenia, basata su immagini satellitari LANDSAT. La maggior parte dell'area di studio ha subito un evidente aumento in termini di ET (74%), che si abbina perfettamente all'aumento della vegetazione arbustiva e alla progressione della foresta. Molte superfici che hanno subito una diminuzione dei tassi di ET, invece, sono state identificate nella categoria d'impiego persistente dei terreni forestali, principalmente nella parte orientale dell'area di studio (76%), un dato che può essere spiegato con il grave evento nevischio verificatosi durante l'inverno del 2014. Gli autori asseriscono che il tasso di variazione di ET stimato può essere considerato un indicatore complementare importante per valutare il processo di cambiamento del paesaggio da un prospettiva più funzionale.

Parole chiave: Carso classico, evapotraspirazione, cambiamento del paesaggio, uso del suolo, NDVI (indice normalizzato differenza vegetazione)

INTRODUCTION

The Karst (Kras, Carso) is a limestone karst plateau, lying above the bay of Trieste in the northernmost part of the Adriatic Sea, and is known for its geological, geomorphological, and speleological phenomena. It is still perceived as a traditionally stony grassland area, where the clear-cuts existed since ancient times and where the black pine (*Pinus nigra*) - planted in the 19th century - is a symbolic tree. The deforestation actually started in Roman times and continued in the Middle Ages with population growth and an orientation to pastoralism. The peak of deforestation, reinforced by the processes of water and wind erosion, which substantially lessen the soil layer (sometimes to bare rock), is thought to have been in the seventeenth to nineteenth centuries (Kaligarič *et al.*, 2006), a fining which was confirmed using reliable cartographic materials such as the Austrian Military survey from the second half of the 18th century (Rajšp & Ficko, 1996). Large socio-economic changes in the first half of the 20th century caused negative demographic changes, which resulted in land abandonment, which became even more pronounced in the period after WWII. Thus, it was already perceived by the 80's that spontaneous reforestation was a key driving force for landscape change in the classic Karst (Feoli & Feoli Chiapella, 1979; Feoli *et al.*, 1980; Feoli & Scimone, 1982; Lausi *et al.*, 1979). These authors produced the first predictions and models, forecasting the forest progression on the abandoned karst grasslands (Favretto & Poldini, 1986); it was forecasted that the Trieste Karst area (the portion of the area on Italian territory) will be completely forested by 2013. The landscape identity really changed, as interpret by Kaligarič *et al.* (2006), but the situation is not so serious: there was still almost 20% of grassland present in 2012 (Kaligarič & Ivajnšič, 2014). However, the trends calculated on the basis of a ten-year time frame verification are straightforward: grasslands could cover 18 km^2 less area in 2025 compared to 2012 and could then shrink to just 6 km^2 (3%) in 2100. The forested area will expand by 18 km^2 by 2025 and could cover 88% of the whole study area by 2075, then achieving an almost steady-state situation in 2100 (Kaligarič & Ivajnšič, 2014). All the previous studies showed that the combined methods involving old maps, remotely sensed data and field surveys clearly show historical trends in assessing and changing the landscape identity – in this case in the classic Slovenian Karst. This methodology allowed us to demonstrate that an almost treeless stony grassland landscape was converted to a forest-dominated landscape in only 250 years (Kaligarič & Ivajnšič, 2014). However, is landscape change only the response of relatively simple two-dimensional input data on vegetation cover or land use? What happens to the landscape when the transition of grassland to scrub, or scrub to forest has occurred? Are there further changes that affect the landscape identity but which are not detectable through simple surface land use data? At this point we could perhaps re-consider the definition of "landscape identity". The definition of the European Landscape Convention is wide: "landscape is an area, as perceived by the people, the character of which is the result of the action and interaction of natural and/or human factors" (Council of Europe, 2000). Nevertheless, the basis for any interaction between the human and natural character of a landscape is its physical features, such as geomorphology (usually not changed), vegetation and climate. Is there any other complementary parameter that could replace or supplement the land use or vegetation cover data in order to better define landscape identity changes?

In this regard, remote sensing offers the promise of several spatially distributed geophysical variables (Brunsell & Gillies, 2000). Vegetation is important in climate studies, owing to its role in the hydrologic cycle with the actual evapotranspiration (ET) rate (Montandon & Small, 2008). ET change is one of the most obvious ecohydrological effects of land use/cover change (Riekerk, 1989; Li *et al.* 2012). Accordingly, remotely sensed land surface reflectance can be used to calculate those parameters such as the green vegetation fraction (Fg) or the Leaf Area Index (LAI), needed to represent vegetation in climate and hydrologic models. These two parameters represent the horizontal and the vertical density of live vegetation, respectively (Gutman & Ignatov, 1997). Both Fg and LAI are normally inferred from the Normalized Difference Vegetation Index (NDVI), an index calculated from reflectance measurements in the red and near-infrared wavelengths. These measurements are typically acquired by satellites over large areas (landscapes) divided into sub-units (pixels) that represents the average reflectance over a smaller area. A frequently used method for calculating Fg is to create a simple linear mixing model between two NDVI endmembers: bare soil NDVI ($NDVI_0$) and full vegetation NDVI ($NDVI\infty$). In fact, the estimate of actual ET on a landscape level can then be calculated as a function of reference evaportranspiration and Fg (Ranade & Irmak, 2008). Many studies have been conducted to address the response of ET to climate change (Goyal, 2004; Diodato *et al.*, 2010; Liu & Yang, 2010), but little work has been done to investigate the impact of land use change on the pattern and process of ET (Jin *et al.*, 2009).

In this paper we initially aimed to identify and measure landscape change, perceived as the fractional green vegetation cover difference between two time windows over a span of 12 years (2002 – 2014). Secondly, the change in estimated actual evapotranspiration as its consequence was simultaneously determined, in order to look into the previously identified changed landscape identity of the classic Karst from a more functional perspective.

MATERIALS AND METHODS

Study area

A major part of the Karst Plateau in Slovenia (202km^2; 85% of the total area, owing to cloudiness in the northernmost part in the 2014 satellite image) was chosen to study relative actual evapotranspiration change over the last 12 years as a function of the green vegetation fraction (Fig. 1). Its geographical position lies between the Adriatic Sea and the Pre-Alpine region in Slovenia and north-eastern Italy (45,77°N and 13,84°E (Fig. 1)). It represents the north-easternmost branch of the Dinaric mountain range. The limestone dominated Karst Plateau stretches from 100 to 500 m a.s.l. and is characterized by its geomorphological phenomena (rocks, karst poljes, dolinas, caves, etc.) (Kaligarič *et al.*, 2006).

Climate conditions are sub-Mediterranean (Ogrin, 1995). The precipitation quantity varies from 900 to 1000 mm by the sea coast directly below the Karst Plateau (Portorož and Trieste), to around 1500 mm directly on the Karst Plateau (Ogrin, 1995). The characteristic strong bora wind causes desiccation and erosion in the area. The mean annual temperature on the Karst Plateau is 12°C (time interval from 1970 to 2000), but the mean annual temperature amplitude reaches 49°C (ARSO, 2015). Poldini (1989) characterized the climate as transitional between Mediterranean and continental pre-Alpine, with rainy cool winters and long dry summers.

NDVI data source

Landsat 5 and Landsat 8 (OLI/TIRS) systematic terrain-corrected (Level 1T) satellite images were obtained for Path 191, Row 28 for June 28, 2002 and June 27, 2014 from the Earth Explorer USGS site (http://earthexplorer.usgs.gov/) in order to gain insight into vegetation density change between the selected time frames (2002 and 2014) in the study area. Both satellite images were converted to reflectance (a physical property of the surface, where values near 0 represent surfaces that are very absorptive at a particular wavelength, and those near 1 very reflective) and additionally processed for atmospheric correction to remove haze with ATMOSC (Landsat 5 image) and LANDSAT (Landsat 8 image) modules in TerrSet (Eastman, 2015) by applying the Dark-object subtraction method. The normalized difference vegetation index (NDVI) for both observed time windows was further calculated by using the appropriate red and near-infrared bands of the satellite images.

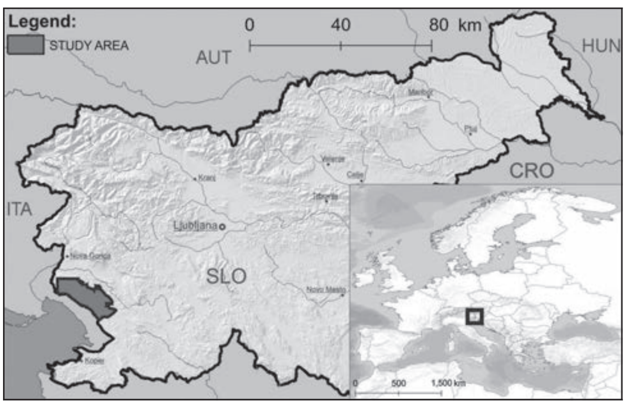

Fig. 1: Geographic position of the study area.
Sl. 1: Geografski položaj obravnavanega območja.

Estimating fractional green vegetation cover change

The fraction of green vegetation cover (Fg) was determined by applying the method proposed by Brunsell and Gillies (2002). This method scales the NDVI to obtain the fraction of vegetation cover and then scales the fraction between the emissivity of bare soil and of a full canopy.

$$Fg = (NDVI - MDVI_0)/(NDVI_{max} - NDVI_0)^2$$

Where $NDVI_0$ is the bare soil NDVI value of the scene and $NDVI_{max}$ is the maximum NDVI value of the scenario corresponding to full cover dense vegetation. It is usually assumed that $NDVI_0$ is close to zero ($NDVI_0$ ~0.05) and is generally chosen from the lowest observed NDVI values. In contrast, Montandon and Small (2008) proved that underestimating $NDVI_0$ yields overestimating the green vegetation fraction. However, because the main focus of this study is orientated towards relative change of actual evapotranspiration between two time windows in the same study area as a function of vegetation density change, the most commonly used $NDVI_0$ value (0.05) was chosen for Fg estimation (Zeng et al., 2000; Oleson *et al.*, 2000; Matsui *et al.*, 2005; Gan & Burges, 2006).

Spatial distribution of reference ET

The reference evapotranspiration (ET_0) data, based on the Penman-Monteith method (ARSO, 2016), from all five adjacent meteorological stations (Bilje, Godnje, Postojna, Vojsko and Portorož) were used to produce a reference evapotranspiration surface for both observed time windows over the study area. The daily mean value of ET_0 for the month of June for each geolocated point representing the meteorological station was calculated and then interpolated by applying the Spline method in ArcGIS 9.3 Spatial analyst tools (ESRI, 2010).

Estimating relative actual ET change

Actual ET (June daily mean in mm/m^2) was calculated by multiplying the fraction of vegetation cover with the reference ET surface for either the 2002 or the 2014 time window (Ranade & Irmak, 2008). Additionally, both ET images were transformed, having a relative scale and then subtracted (ET2014 - ET2002), resulting in a relative ET difference map measured in proportion of change.

The relation between landscape and actual ET change

In order to link change in actual ET between the observed time span with the land use change processes which took place in the study area, the resulting actual ET difference image was ovelayed with the land use change (transition from one to another category) and persistence maps developed with the Land Change Modeler tool in Terrset (Eastman, 2015). The Zonal statistics module within ArcGIS 9.3 Spatial analyst tools was applied to determine mean relative actual ET change and the corresponding standard deviation per land use transition or persistence category identified beneath the ET loss or ET gain areas. Land use data for both observed time windows (2002 and 2014) were gathered from the freely accessible database owned by the Slovenian Ministry of Agriculture, Forestry and Food (http://rkg.gov.si/GERK/; 4.1.2016).

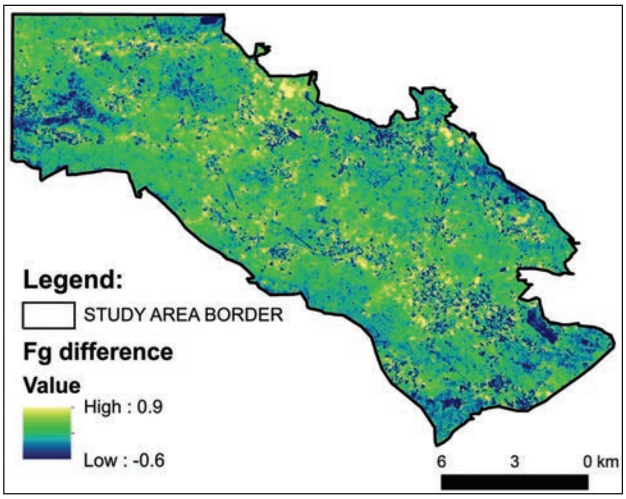

Fig. 3: The differences in fractional green vegetation cover in the study area between 2002 and 2014.
Sl. 3: Razlika v deležu vegetacijskega pokrova na obravnavanem območju med letoma 2002 in 2014.

RESULTS

12 years of land use and vegetation density change

A decreasing trend in the land use categories of grassland, overgrowing and fields was detected (Fig. 2). The largest retreat in area can be assigned to the grassland category (4.4%), followed by overgrowing areas (3.1%), which were mostly replaced by forest (in 98%). The latter expanded to 33.7 km^2 (5.7 % of area), followed by an 2.3 km^2 (0.4%) increase in settlement and infrastructure area.

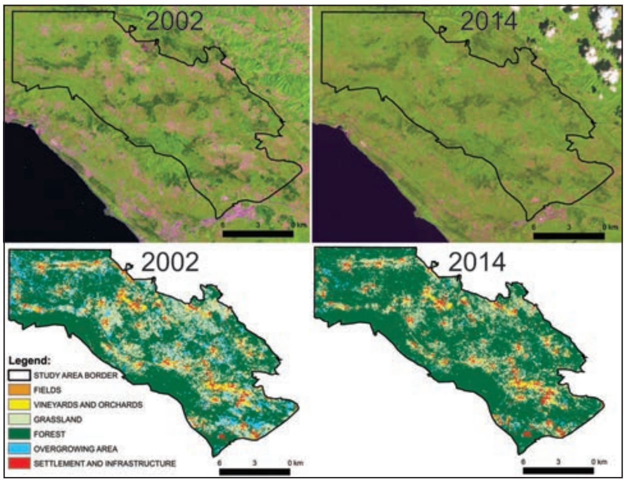

Fig. 2: False color composite LANDSAT satellite images of the study area in 2002 and 2014 with corresponding land use maps.
Sl. 2: LANDSAT satelitski posnetek ter raba tal na obravnavanem območju v letih 2002 in 2014.

However, the NDVI, based on LANDSAT imagery (Fig. 2), enabled the estimation of fractional green vegetation cover (Fg) change in the study area between 2002 and 2014 (Fig. 3). In only 2.1% of the study area (4,2 km^2) was a decrease in fraction of green vegetation within a pixel detected. Two square kilometers of area remained unchanged, whereas all other parts of the observed classic Karst area (196.8 km^2) did in fact increase in vegetation greenness. The intensity of Fg change in those 12 years is measured in a range from a 60% decrease to a 90% increase.

Spatial distribution of actual evapotranspiration change as a climatic indicator for landscape identity change

By comparing the June daily mean reference ET surfaces of 2002 and 2014, a general spatial pattern can be recognized (Fig. 4). There is a clear decreasing ET trend from the SW to the NE direction, which has recently become more pronounced (Fig. 4B). The largest difference in the June daily mean reference ET between the two time windows was observed at the Godnje and Vojsko meteorological stations (both with a 0.6 mm/m^2 decrease). The other three stations do not differ more than 0.1 mm/m^2 in June daily mean reference ET.

However, the estimate of the June daily mean actual ET difference as a function of fractional green vegetation cover change, triggered by land use dynamics, shows a more detailed geospatial pattern of local climate change (Fig. 5A, B). In 17.6% of the study area (35.5 km^2), mo-

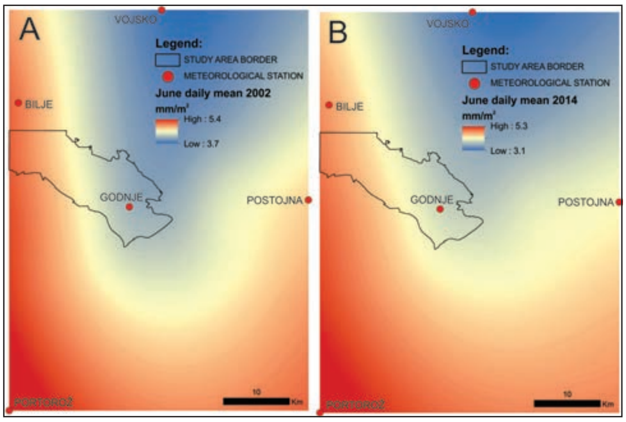

Fig. 4: Reference evapotranspiration surfaces (daily mean in mm/m²) for June in 2002 (A) and 2014 (B).
Sl. 4: Prostorska razporeditev povprečne dnevne junijske referenčne evapotranspiracije v letu2002 (A) in letu 2014 (B).

stly in the E and SE part, a clear decrease in actual ET (ET Loss) can be detected. An area of 17.4 km² (8.6%), more or less randomly scattered over the study area, remained constant, according to the June daily mean actual ET (ET Persistence). Consequently, almost 74% of the area (149.4 km²) shows a clear increase (up to 75%) in ET (ET Gain). The northern part of the observed classic Karst has evidently been pumping more water into the June atmosphere in recently than it was in 2002.

By looking into the estimated actual ET loss category from the angle of land use dynamics between 2002 and 2014, it became clear that 23% of the superficial cover in that category did in fact change in land use, while 77% persisted (Table 1). In other words, the estimated actual ET rate has been lower recently, even though most areas remained under the same land use (76% forest, 17% grassland, 3% vineyards and orchards). The highest average decrease in actual ET, measured at 9%, was detected in the Vineyards and orchards land use category, followed by Fields (8%) and Settlements and infrastructure (6%). The highest percentage of area exhibiting a land use transition and simultaneously an actual ET decrease surprisingly coincided with the Grassland to Forest transition (25%) and the Overgrowing area to Forest transition (27%). On the other hand, these two transitions have the lowest negative mean change in actual ET (-4% and -5%) compared to other land use transitions. The highest relative mean change in actual ET belongs, as expected, to the transition Grassland to Settlement (-11%).

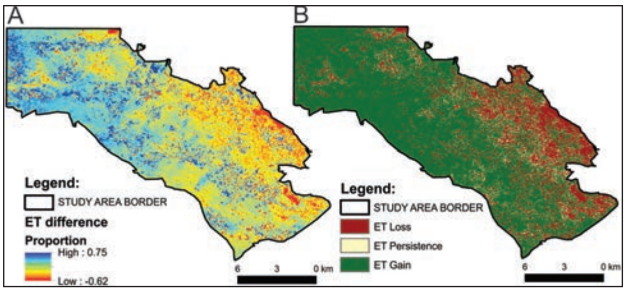

Fig. 5: Relative actual ET difference between 2002 and 2014 in the study area (A) and the indication of ET loss, gain and persistence distribution (B).
Sl. 5: Prostorska razporeditev relativne razlike v povprečni dnevni junijski ET med letoma 2002 in 2014 (A) ter območja izgubljanja, ohranjanja in pridobivanja vrednosti ET(B).

In the actual ET gain category, 25% of the area corresponds to changed land use, whereas 75% relates to persistent land use. Here, as expected, Grassland to Forest (32%) and Overgrowing area to Forest (30%) are the most frequent land use transitions showing an actual ET increase. Nevertheless, the highest positive mean change in actual ET is recorded in the Grassland to Vineyards and orchards transition (15%), followed by the transition Field to Grassland (14%). As in the actual ET loss category, even in this case the estimated actual ET change trend (now positive) is superficially grater in persistent land use, which indicates the ongoing landscape change process beyond the simple two-dimensional scale of geospatial land use data.

DISCUSSION

We found that by far the largest proportion of the study area has faced a clear gain in ET, which perfectly matches with the increased scrub encroachment on grassland surfaces in the given time frame, following the fact that more scrub/trees means higher ET. However, this was already well documented in the literature; scrub encroachment actually has many functional effects, among which, the increased evapotranspiration estimate is one of most visible and measurable (Zhang *et al.*, 2001; Huxman *et al.*, 2005). Further increases in evapotranspiration occur in conjunction with forest progression. We found that, among those polygons where land use has changed and ET increased, one- third of the surfaces represent the transition "grassland to forest" and another third the transition "overgrowing areas to forest", which was expected according to the above mentioned trends. However, the surprising outcome of this study is that, among the total area which gained ET, 75% are "land use persistence" polygons. In other words, for three-quarters of the areas with increased evapotranspiration, no land use change was detected between the given time windows. From the view of the two-dimensional vegetation perception of the landscape, nothing has changed here. Of course, most changes occurred in the most widespread land use categories – forest and grassland. 70% of the areas where land-use was stable but ET increased are forests. It explains that

Table 1: The relation between relative actual ET change and land use dynamics in the study area.
Tabela 1: Zveza med relativno spremembo v ET in procesom spreminjanja rabe tal med letoma 2002 in 2014.

LAND USE CATEGORY		ET GAIN			ET LOSS		
		% AREA	MEAN CHANGE IN %	STD	% AREA	MEAN CHANGE IN %	STD
	Total percentage of area corresponding to persistent land use	75			77		
LAND USE PERSISTENCE	FIELDS	0.6	14.1	8.8	0.5	-8.0	6.3
	VINEYARDS AND ORCHARDS	2.5	12.1	8.3	3.3	-9.0	8.9
	GRASSLAND	22.2	11.7	7.8	17.4	-5.9	4.9
	FOREST	69.6	8.3	5.2	75.7	-4.8	4.5
	OVERGROWING AREA	1.4	9.7	6.1	0.8	-5.2	6.2
	SETTLEMENTS AND INFRASTRUCTURE	3.6	9.2	5.9	2.2	-6.4	5.8
	Total percentage of area corresponding to changed land use	25			23		
LAND USE CHANGE	GRASSLAND to FIELD	3.0	11.8	8.1	5.1	-8.9	7.0
	GRASSLAND to VINEYARDS AND ORCHARDS	3.3	14.6	9.4	3.2	-7.6	6.0
	FIELD to GRASSLAND	6.1	14.2	8.7	4.8	-7.7	6.0
	VINEYARDS AND ORCHARDS to GRASSLAND	2.3	11.6	7.8	3.3	-8.1	6.4
	FOREST to GRASSLAND	3.3	10.1	6.8	5.5	-7.4	7.5
	OVERGROWING AREA to GRASSLAND	2.8	8.9	5.9	3.4	-6.1	6.3
	GRASSLAND to FOREST	31.9	9.5	6.0	24.9	-4.4	3.8
	OVERGROWING AREA to FOREST	29.7	8.8	5.5	26.7	-4.8	4.5
	GRASSLAND to OVERGROWING AREA	6.4	10.8	7.0	3.9	-5.6	5.5
	FOREST to OVERGROWING AREA	1.9	13.7	11.8	2.2	-7.6	7.0
	GRASSLAND to SETTLEMENTS AND INFRASTRUCTURE	1.5	10.9	7.0	3.5	-10.8	10.1
	LAND USE TRANSITION BELOW THE 10 Ha TRESHOLD	8.0	0.0	0.0	13.0	0.0	0.0

when forest is perceived, its development has not ceased: succession is an ongoing process, where woody species turnover takes place, and the trees are growing and increasing their above-ground phytomass.

Thus, if functional features of the landscape are investigated, the simple forest/non-forest landscape categorization is simply too weak. The age of the forest, or at least roughly defined forest typology, is essential to explain the relation between the ET change.

Furthermore, 20% of the area where land-use has not changed and ET nevertheless increased, constitutes grassland. This means that some functional differences must have occurred in that time interval, even though grasslands were perceived. However, the weakness of remotely sensed data was discussed and questioned from the early beginning of remote sensing tools development (*e.g.* Congalton & Green, 2008). How remotely sensed data can lead to misleading results, if no measurements, or at least observations, are made on the ground, has been shown in several examples. One of these refers to the study area: Watts (2004) identified eleven "communities" along the altitudinal range on the basis of satellite survey data only.

However, among them, two "communities" do not exist in the northern Balkans at all, and other types were incorrectly geo-located and named.

The discrepancy between the remotely sensed map of agricultural land use and a field-surveyed habitat (vegetation) map was substantially found in the study by Kaligarič *et al.* (2006), performed on 626 Ha in the same Karst area. With remote sensing, only one half of the identified grasslands were found to be without tall-herb invasions (*Apiaceae*, *Dictamnus albus, Thalictrum aquilegiifolium, Paeonia officinalis, Asparagus acutifolius*) or dominance of forest edge species (*Geranium sanguineum, Polygonatum odoratum, Aconitum, Aquilegia*). These are all long-leaved perennial plants, which have been recognized to decline slowly and may survive for decades after environmental change (Eriksson, 1996; Helm *et al.*, 2006; Lindborg, 2007). Since there may exist a considerable time lag between the onset of habitat change (abandonment) and the final demise of populations (Eriksson & Ehrlén, 2001), the fragmented grasslands are still floristically rich, but their floristic composition has changed in favour of long-leaved perennials; among these, most are tall herbs with substantial above-ground phytomass, prone to high evapotraspiration rates. In other words – within the category "grassland" identified by remote sensing tools, substantial functional and morphological changes can occur derived from species turnover and plant growth.

Can however, the opposite also appear? Tat ET rates on the surface decline within the time frame, while the land-use category remains unchanged? Of course, it is crucial here in which time period of the year the near infra-red (satellite) images are taken – in the beginning, at the peak, or at the end of the vegetation cycle. We considered and processed satellite images that were taken in the same time period in both time windows (one day difference), in order to minimize the difference regarding the vegetation development stage. However, there are also surfaces where ET decreased in the unchanged land-use category. Here, by far the highest rates again belonged to forest (76% of all such surfaces). This would be hard to explain if the map (Fig. 5) had not shown that such cases are concentrated in the eastern part of the study area. This part was severely damaged by sleet during the winter of 2014. The spatial data (http://www.zgs.si/slo/delovna-podrocja/varstvo-gozdov/sanacija--posledic-ujme-2014/index.html; 20.11.2015) show that the areas damaged by varying quantities of sleet overlap perfectly with the forest category in which an ET decrease was identified. Sleet substantially affected the landscape of Slovenia in 2014 (mostly in the central and western regions). Some trees collapsed; some of them lost their usual appearance, owing to reduced canopies, and the forest tree composition might change in the long run, not to mention potential forest pests, which spread out on the damaged wood (Chen & Yang, 2009). Are these factors the precise ones that can change landscape identity?

We can conclude that the estimated ET rate can be an important indicator in assessing landscape change from a more functional perspective than from a rather static approach to land-use or vegetation change. So, the final answer to the question raised in the title of the paper is "yes": there are several landscape attributes – from climatic and natural, to cultural and socio-economic – which are influenced by ET and contribute to a changed landscape identity, which goes far beyond the usual two-dimensional assessment of land use change.

ALI LAHKO EVAPOTRANSPIRACIJO SMATRAMO KOT DODATNI POKAZATELJ ZA RAZUMEVANJE SPREMENJENE IDENTITETE KLASIČNEGA KRASA?

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POVZETEK

Sprememba evapotranspiracije (ET) je ena izmed najbolj očitnih sprememb povezanih s spremembo rabe tal oziroma vegetacijske odeje; povezava med njima pa je še slabo poznana. V tem prispevku smo krajinske spremembe najprej zaznali kot spremembo vegetacijske odeje med dvema časovnima oknoma (2002 – 2014), nato pa to spremembo povezali s spremembami v ocenjeni dnevni ET za mesec junij na območju klasičnega Krasa v Sloveniji, pri čemer smo se poslužili posnetkov satelita LANDSAT. Tako smo relativne razlike v ET povezali z dinamiko spremenjene rabe tal v omenjenem časovnem intervalu in tako pogledali na spreminjanje kraške identitete z bolj "funkcionalnega" zornega kota. Na večini površine (74%) se je ET v obdobju 12 let povečala, kar se ujema z dejstvom da se krajina zarašča; najprej z grmišči in nato z gozdom, kar pomeni višje vrednosti ET. Vendar pa so površine s povečano ET sovpadale tudi s površinami, kjer v časovnem intervalu ni bilo sprememb, še posebno v kategoriji gozd (75%). To je bilo še posebej očitno na vzhodnem delu območja, kar razlagamo s hudim žledom pozimi 2014. Lahko zaključimo, da je sprememba v ocenjeni ET lahko pomembno orodje in dopolnilna mera za obravnavo krajinskih sprememb z bolj »funkcionalnega vidika«. S tega stališča bi morali morda pojem »krajinske identitete« ustrezno razširiti.

Ključne besede: klasični Kras, evapotranspiracija, krajinske spremembe, raba tal, NDVI

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