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UTJECAJ KONTINENTALNOSTI KLIME NA DUGOGODIŠNJE TRENDOVE KOLIČINE PADALINA U HRVATSKOJ

INFLUENCE OF THE CONTINENTALITY ON LONG-TERM PRECIPITATION TRENDS IN CROATIA

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Izvod

U radu se ispituje utječe li stupanj kontinentalnosti klime na dugogodišnje trendove količine padalina u Hrvatskoj. Analizirani su podaci 23 meteorološke postaje za razdoblje 1950.-2007. godine. Prema dugogodišnjem trendu u tom je razdoblju količina padalina na svim postajama u Hrvatskoj (osim Dubrovnika) pokazala vrlo malu promjenljivost ili stagnaciju. Pokazalo se da stupanj kontinentalnosti nema bitan utjecaj na jačinu dugogodišnjih linearnih trendova količine padalina.

Ključne riječi: stupanj kontinentalnosti, padaline, Hrvatska, 1950.-2007. godine

Abstract

This paper examines whether the degree of the continentality influences the long-term precipitation trends in Croatia. Data from 23 meteorological stations were analysed for the period 1950–2007. According to the long-term trends in this period, precipitation levels have shown very little change, or stagnation, at all stations in Croatia (with the exception of Dubrovnik). It has been shown that the level of continentality has no significant influence on the long-term linear precipitation trends.

Key words: degree of continentality, precipitation, Croatia, period 1950–2007

UVOD

Proučavanje klimatskih promjena postalo je na globalnoj razini najintrigantniji aspekt klimatoloških istraživanja. Pritom se osobita pozornost pridaje istraživanju globalnog zatopljenja, tj. promjenama temperature zraka, a mnogo manje promjenama ostalih klimatskih elemenata, među kojima su i padaline. I dok globalno zatopljenje većina znanstvenika pripisuje antropogenom utjecaju, uz sve jaču struju koja naglašava važnost prirodnih procesa, promjene u količini padalina uglavnom se samo registriraju bez određivanja jasnih kauzalnih veza. Sjevernoatlantska oscilacija i promjena učestalosti ciklogeneze mogući su, ali još uvijek nepotvrđeni uzroci.

Promjena količine padalina u Hrvatskoj predmet je više radova domaćih autora (Penzar et al. 1967; Šegota, 1969; Gajić-Čapka 1992; Gajić-Čapka 1994; Gajić-Čapka, Zaninović, 2006.). Pojedini od tih radova baziraju se na izabranim postajama i cjelogodišnjim vrijednostima, a u nekima se analiziraju sezonske vrijednosti.

INTRODUCTION

The study of climate change has become the most intriguing aspect of climatology research worldwide. Particular attention has been paid to researching global warming, i.e. changes in air temperatures, with less focus on researching other climatic changes, including precipitation. While global warming has been attributed to anthropogenic impacts by many authors, with an increasing movement that stresses the importance of natural processes, changes in precipitation levels are usually only registered without determining clear causal relationships. The North Atlantic oscillation and changes to cyclogenesis frequencies are possible, though yet unconfirmed, causes.

Changes in precipitation levels in Croatia have been the subject of several papers (Penzar et al. 1967; Šegota, 1969; Gajić-Čapka 1992; Gajić-Čapka 1994; Gajić-Čapka, Zaninović, 2006). Some of these were based on selected stations and year-round values, while only seasonal values were examined in others.

Cilj ovog rada je istražiti do kakvih je promjena u količini padalina u Hrvatskoj došlo tijekom druge polovice 20. stoljeća i ispitati utječe li kontinentalnost klime na višegodišnje trendove količine padalina. Poznavanje promjena u količini padalina geografski je vrlo značajno, poglavito zbog opskrbe stanovništva vodom, ali i korištenja vode u gospodarskim djelatnostima.

The objective of this paper is to examine whether changes in precipitation levels have occurred during the second half of the 20th century, and to examine whether the continentality of the climate has impacted the long-term precipitation trends. Knowledge of changes in precipitation levels is very important geographically, primarily for the supply of water for the population and the use of water for economic activities.

PODACI I METODE

Uzimajući u obzir reljefnu dinamičnost Hrvatske, mreža meteoroloških postaja, posebice glavnih, nije do-

DATA AND METHODS

For the purposes of a regional analysis, the network of Croatia's meteorological stations, particularly the main

Sl. 1. Geografska raspodjela meteoroloških postaja: 1-Osijek, 2-Slavonski Brod, 3-Donji Miholjac, 4-Bjelovar, 5-Križevci, 6-Koprivnica, 7-Varaždin, 8-Zagreb-Maksimir, 9-Karlovac, 10-Ogulin, 11-Gospić, 12-Rovinj, 13-Pazin, 14-Rijeka, 15-Crikvenica, 16-Senj, 17-Mali Lošinj, 18-Zadar, 19-Šibenik, 20-Split-Marjan, 21-Hvar, 22-Lastovo, 23-Dubrovnik

Fig. 1. Geographical distribution of the meteorological stations: 1-Osijek, 2-Slavonski Brod, 3-Donji Miholjac, 4-Bjelovar, 5-Križevci, 6-Koprivnica, 7-Varaždin, 8-Zagreb-Maksimir, 9-Karlovac, 10-Ogulin, 11-Gospić, 12-Rovinj, 13-Pazin, 14-Rijeka, 15-Crikvenica, 16-Senj, 17-Mali Lošinj, 18-Zadar, 19-Šibenik, 20-Split-Marjan, 21-Hvar, 22-Lastovo, 23-Dubrovnik

voljno zadovoljavajuća za detaljnu regionalnu analizu. To svakako valja imati na umu pri interpretaciji rezultata prostorne raspodjele klimatskih elemenata. Zbog toga neki autori ponekad pribjegavaju analizi podataka jedne postaje, tretirajući je reprezentativnom za šire područje, što ne mora uvijek biti točno.

U ovom su radu analizirani podaci o godišnjim količinama padalina na 23 meteorološke postaje (sl. 1). Analizirano je 58-godišnje razdoblje 1950.-2007. godine, tj. grubo uzevši, druga polovica 20. stoljeća. Odabrane su postaje: Osijek, Slavonski Brod, Donji Miholjac, Bjelovar, Križevci, Koprivnica, Varaždin, Zagreb-Maksimir, Karlovac, Ogulin, Gospić, Rovinj, Pazin, Rijeka, Crikvenica, Senj, Mali Lošinj, Zadar, Šibenik, Split-Marjan, Hvar, Lastovo i Dubrovnik. Udio interpoliranih vrijednosti je minimalan i sveukupno za sve stanice iznosi samo 0,4% svih godišnjih podataka. Grafički su prikazane vrijednosti padalina za sve postaje, a na temelju toga su izračunati klizni srednjaci i linearni trend metodom najmanjih kvadrata.

Za određivanje kontinentalnosti klime najviše se koristi Conradova (1946) prerada formule Gorczyńskog (1920), iako su u uporabi i drugi indeksi (Toros i dr., 2008). Ta formula uzima u obzir godišnju termičku amplitudu i sinus geografske širine, u odnosu

$$k = 1{,}7\ [A/(\sin\phi+10)] - 14$$

gdje je A= godišnja termička amplituda, ϕ= geografska širina.

Na kraju su jačine trendova ispitane u ovisnosti o stupnju kontinentalnosti.

REZULTATI

Godišnje vrijednosti količina padalina, dakako, pokazuju velike međugodišnje varijacije. Za izglađivanje krivulje korišteni su 10-godišnji klizni srednjaci (sl. 2). Iz njih je vidljivo da se na svim postajama mogu izdvojiti manje ili više izraženi periodi s nešto višom i periodi s nešto nižom godišnjom količinom padalina. Posebno je uočljivo razdoblje od 1980. do 2000. godine u kojem se na većini analiziranih postaja bilježi pad količine padalina s minimumom početkom 90-ih godina. Odstupanja od takve sheme vidljiva su u Koprivnici, Varaždinu, Rovinju i naročito Dubrovniku, gdje je taj pad počeo deset godina ranije nego drugdje, te u Križevcima, Zagreb-Maksimiru i Gospiću koji u istom razdoblju bilježe stagnaciju. S tim u skladu, na svim postajama bi se mogla izdvojiti dva ili tri sukcesivna trenda krećeg trajanja, ali takvi trendovi nisu cilj ovog rada.

Petgodišnji pokretni srednjaci za neke postaje (sl. 3) pokazali su cikluse unutar kojih dolazi do povećanja i

ones, is insufficient due to the country's dynamic relief. This should certainly be considered in interpreting the results of the spatial division of climatic elements. For this reasons, some authors analize the data from one station, treating it as representative for a broader area, which need not always be correct.

This paper analyses data on annual precipitation levels of 23 meteorological stations (Fig. 1). A 58-year period, from 1950–2007 was analysed, i.e. the second half of the 20th century. The following stations were selected: Osijek, Slavonski Brod, Donji Miholjac, Bjelovar, Križevci, Koprivnica, Varaždin, Zagreb-Maksimir, Karlovac, Ogulin, Gospić, Rovinj, Pazin, Rijeka, Crikvenica, Senj, Mali Lošinj, Zadar, Šibenik, Split-Marjan, Hvar, Lastovo and Dubrovnik. The share of interpolated values is minimal and totals only 0.4% of all annual data for all stations. The precipitation levels for all stations is shown graphically. Based on these, the moving averages and linear trends were calculated using the least squares method.

Several indices are in use to determine the continentality of the climate (e.g. Toros et al., 2008), though Conrad's (1946) adaptation of the Gorczyński formula (1920) is most commonly applied. This formula considers the annual thermal amplitude and sinus of the geographic latitude, in the equation:

$$k = 1{,}7\ [A/(\sin\phi+10)] - 14$$

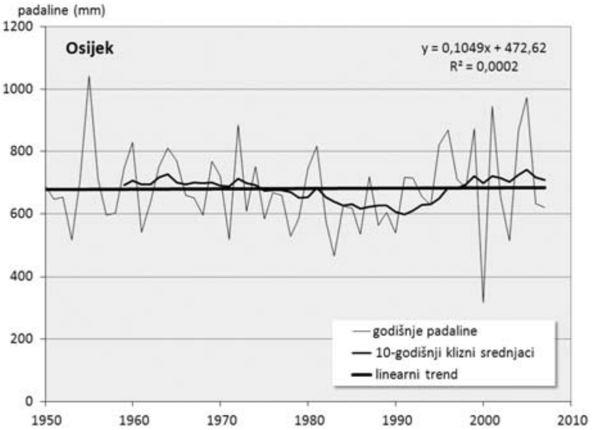
where A = annual thermal amplitude and ϕ = geographic latitude.

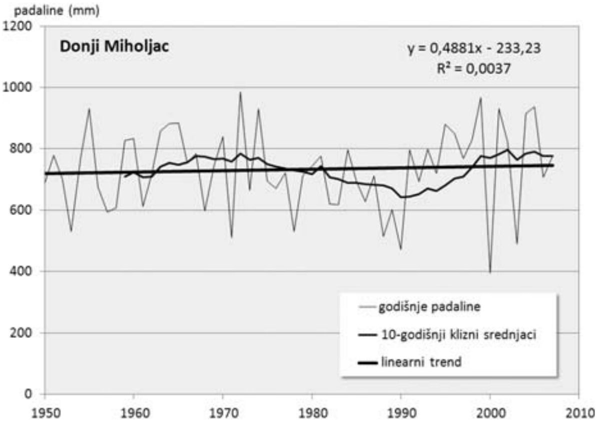
Finally, the strength of the trends were tested to see whether they correlated with the degree of continentality.

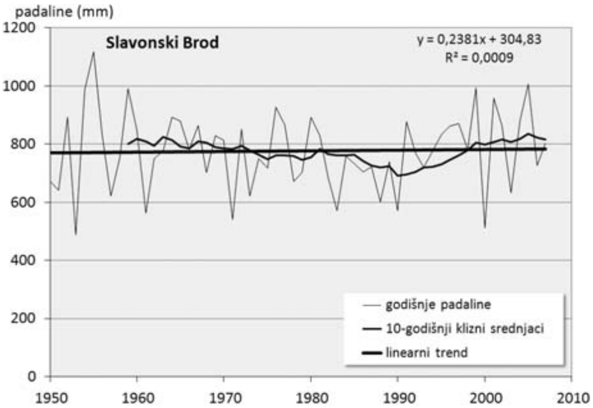
RESULTS

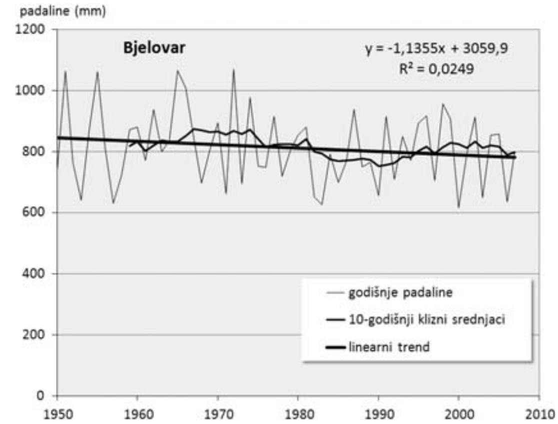
The annual precipitation levels show large variations between years. In order to even out the curve, 10-year moving means were used (Fig. 2). These show that at all stations it is possible to distinguish more or less pronounced periods with higher precipitation and periods with lower annual precipitation levels. The period from 1980 to 2000 stands out in particularly, where a drop in precipitation was recorded at most stations, with the minimum in the early 1990s. Exceptions from this trend are seen in Koprivnica, Varaždin, Rovinj and especially Dubrovnik, where this drop in precipitation levels began ten years earlier than at other stations, and in Križevci, Zagreb-Maksimir and Gospić which recorded a stagnation during the same period. Accordingly, two to three successive trends of shorter duration can be distinguished for each station, however, these trends are not within the scope of this paper.

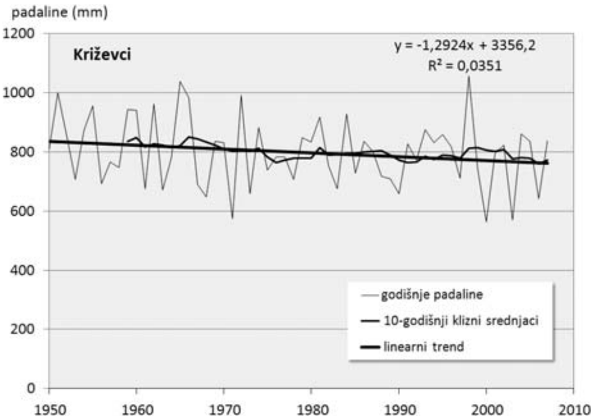
The five-year moving means for some stations (Fig. 3) indicate cycles within which the precipitation levels are

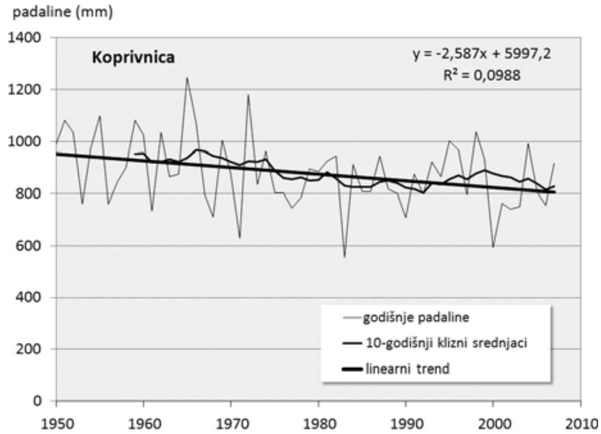

padaline (mm)
Osijek
y = 0,1049x + 472,62
R² = 0,0002
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

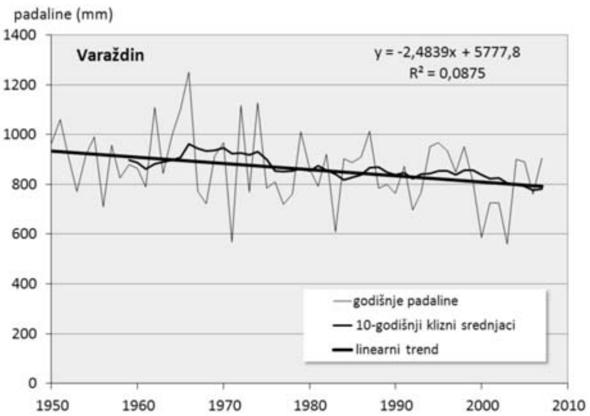

padaline (mm)
Donji Miholjac
y = 0,4881x - 233,23
R² = 0,0037
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

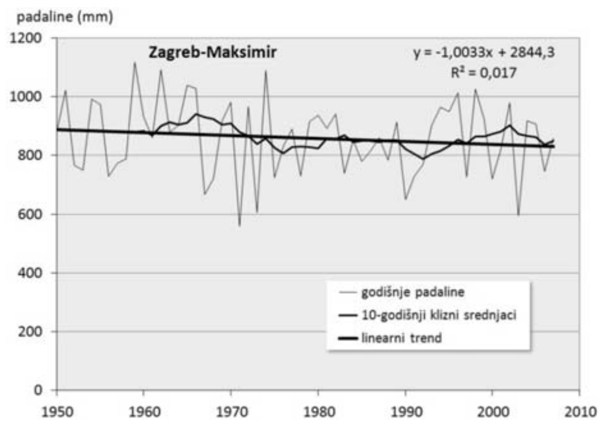

padaline (mm)
Slavonski Brod
y = 0,2381x + 304,83
R² = 0,0009
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

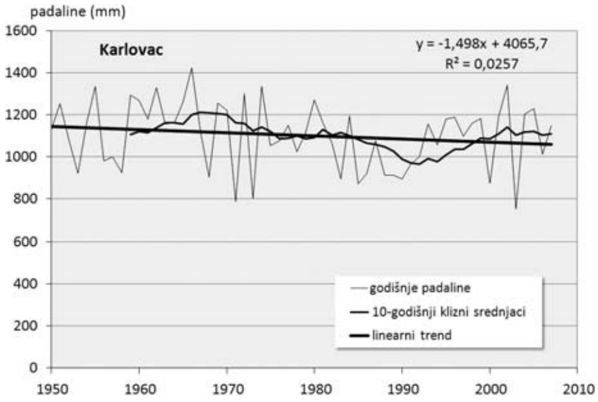

padaline (mm)
Bjelovar
y = -1,1355x + 3059,9
R² = 0,0249
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

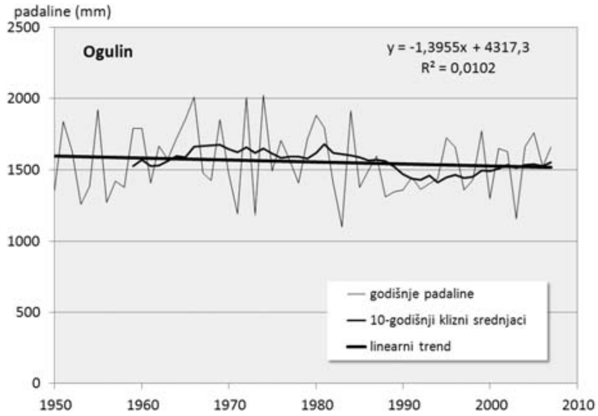

padaline (mm)
Križevci
y = -1,2924x + 3356,2
R² = 0,0351
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

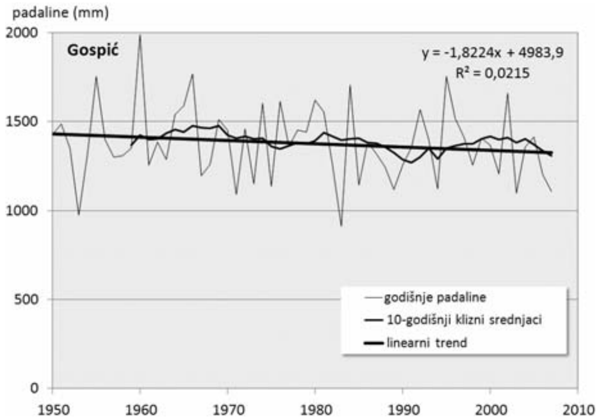

padaline (mm)
Koprivnica
y = -2,587x + 5997,2
R² = 0,0988
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

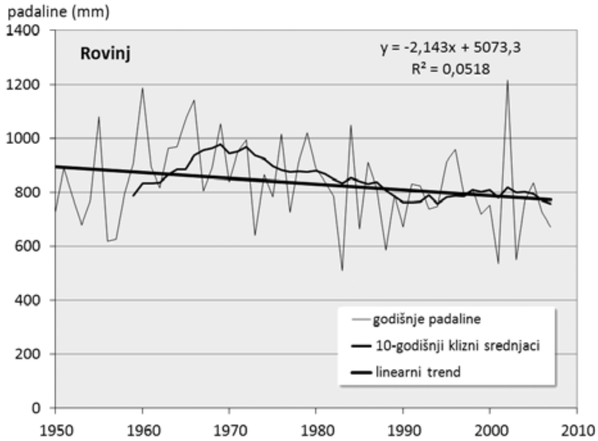

padaline (mm)
Varaždin
y = -2,4839x + 5777,8
R² = 0,0875
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

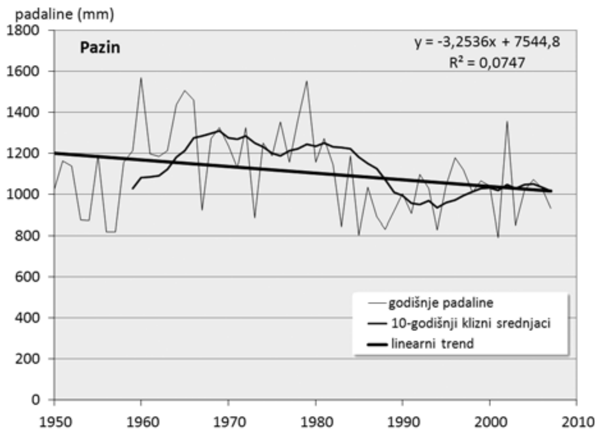

padaline (mm)
Zagreb-Maksimir
y = -1,0033x + 2844,3
R² = 0,017
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

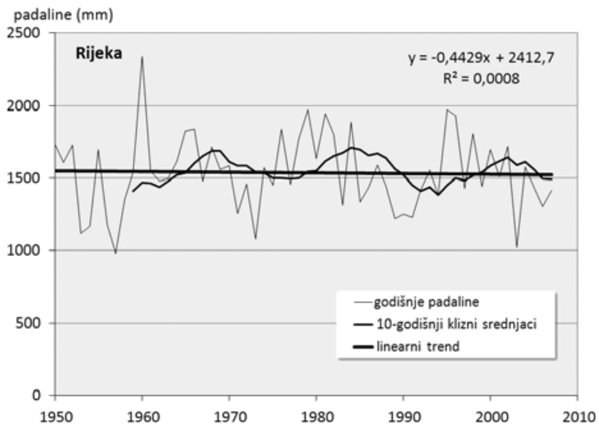

padaline (mm)
Karlovac
y = -1,498x + 4065,7
R² = 0,0257
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

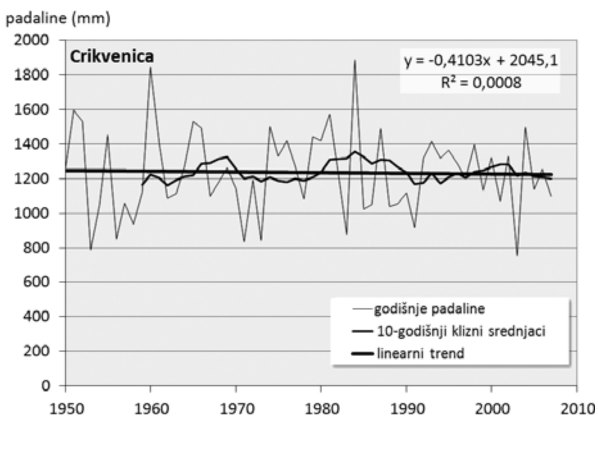

padaline (mm)
Ogulin
y = -1,3955x + 4317,3
R² = 0,0102
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

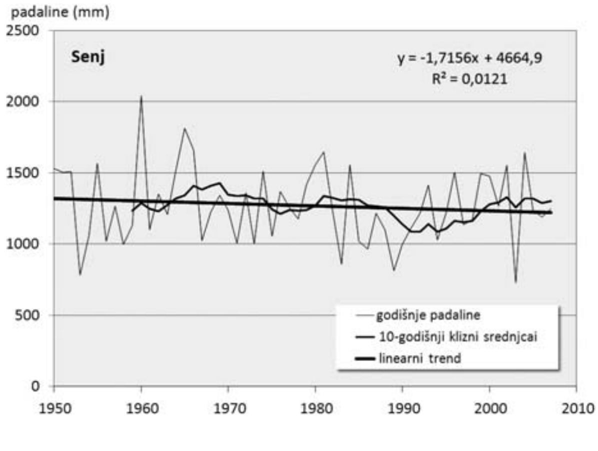

padaline (mm)
Gospić
y = -1,8224x + 4983,9
R² = 0,0215
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

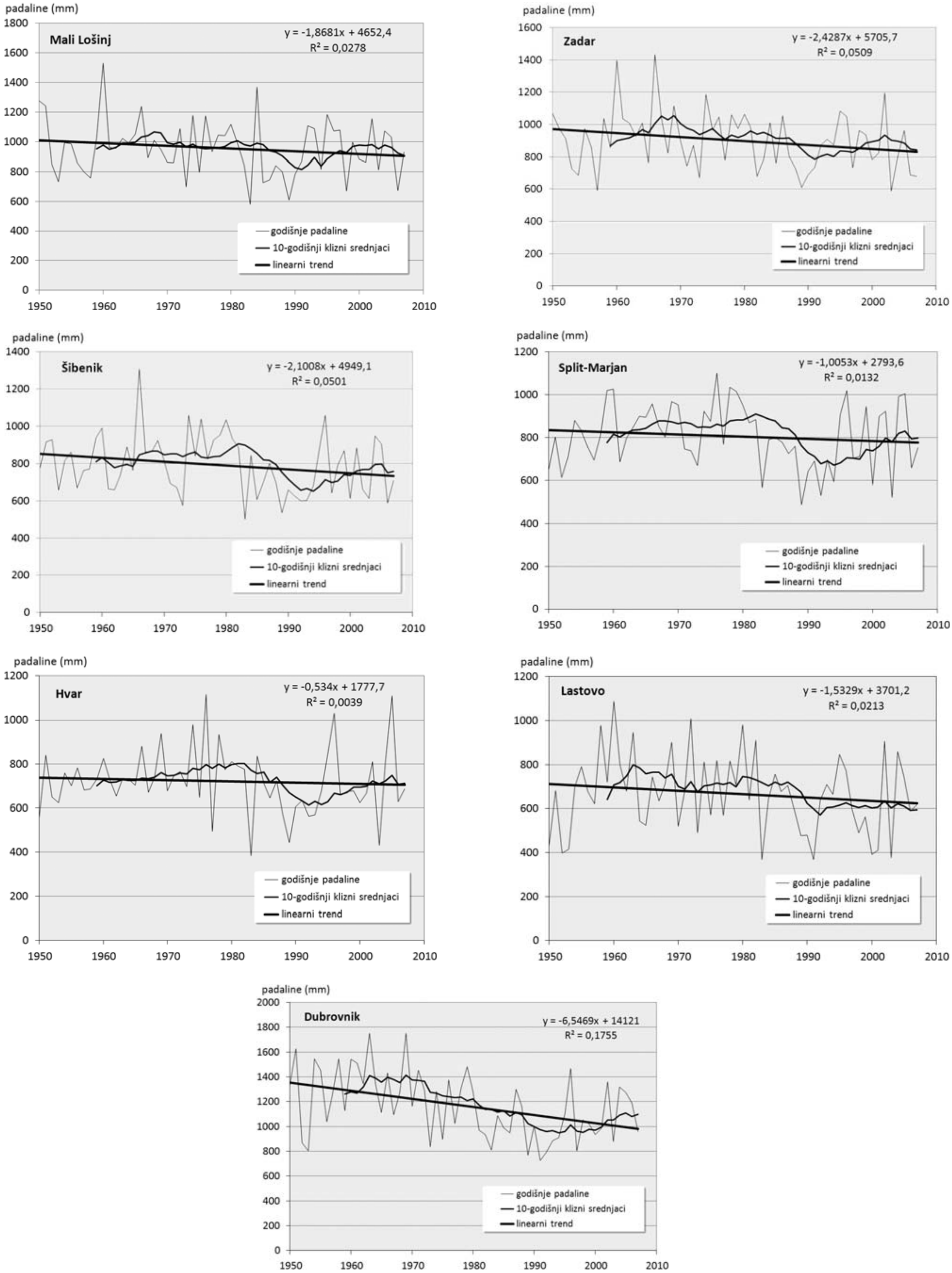

padaline (mm)
Rovinj
y = -2,143x + 5073,3
R² = 0,0518
godišnje padaline
10-godišnji klizni srednjaci
linearni trend


padaline (mm)
Pazin
y = -3,2536x + 7544,8
R² = 0,0747
godišnje padaline
10-godišnji klizni srednjaci
linearni trend


padaline (mm)
Rijeka
y = -0,4429x + 2412,7
R² = 0,0008
godišnje padaline
10-godišnji klizni srednjaci
linearni trend

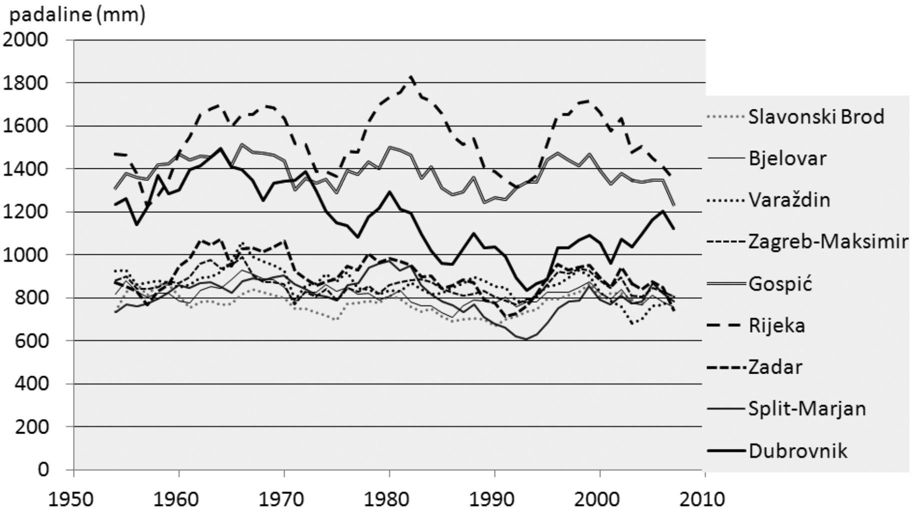

padaline (mm)
Crikvenica
y = -0,4103x + 2045,1
R² = 0,0008
godišnje padaline
10-godišnji klizni srednjaci
linearni trend


padaline (mm)
Senj
y = -1,7156x + 4664,9
R² = 0,0121
godišnje padaline
10-godišnji klizni srednjcai
linearni trend



Sl. 2. Godišnje količine padalina, 10-godišnji klizni srednjaci i linearni trendovi za razdoblje 1950.-2007.

Fig. 2. Annual precipitation levels, 10-year moving means and linear trends for the period 1950–2007



Sl. 3. Petgodišnji klizni srednjaci godišnje količine padalina 1950.-2007.
Fig. 3. Five-year moving means of precipitation levels for the period 1950–2007

smanjenja količine padalina. Periodičnost ciklusa padalina u Hrvatskoj već je bila predmet nekih istraživanja (Gajić-Čapka, 1992; Gajić-Čapka, 1994; Cvitan, 1998).

Usporedbom linearnih trendova (sl. 2) možemo zaključiti da, osim Dubrovnika, niti na jednoj postaji nije došlo do značajnijih promjena količine padalina. U istočnoj Hrvatskoj taj trend stagnira ili bilježi tek neznatan porast. U ostalim dijelovima Hrvatske trend pokazuje stagnaciju ili pad. Smanjenje količine padalina u promatranom je razdoblju najizrazitije u Dubrovniku (65 mm svakih 10 godina) čime se ta postaja bitno izdvaja od svih ostalih u Hrvatskoj. Prema smanjenju količine padalina na drugom je mjestu Pazin s 33 mm na svakih 10 godina, a na svim ostalim postajama to smanjenje ne prelazi 25 mm.

Važno se osvrnuti i na reprezentativnost samih trendova. Prema vrijednostima koeficijenata determinacije koji su upisani u grafikon svake postaje, proizlazi da linearni trendovi nisu najbolji izbor, tj. da se ne prilagođavaju najbolje godišnjim vrijednostima. Očito bismo bolje prilagođavanje postigli polinomnim trendom što višeg stupnja. Autori su napravili i takvu analizu, ali ona u ovom radu zbog limitacije njegova opsega nije grafički prezentirana. Možemo samo spomenuti da je primijećeno kako se polinomni trend šestog stupnja prilično podudara s kliznim srednjacima, u nekim slučajevima čak do te mjere da ga, s obzirom na složenost takvog trenda, klizni srednjaci mogu i zamijeniti.

Usprkos tome, linearni trend kao jedna od osnovnih statističkih analiza vremenskog niza, daje nam vjerodostojnu informaciju o ukupnoj promjeni koja je nastupila između početne i završne točke tog niza, što u ovom slučaju znači razliku u količini padalina od 1950. do zaključno 2007. godine, s tim da moramo biti svjesni činjenice da su u cijelom tom razdoblju postojale velike

increased and reduced. The periodicity of the precipitation cycles in Croatia has been analysed by other authors (Gajić-Čapka, 1992; Gajić-Čapka, 1994; Cvitan, 1998).

In the comparison of the linear trends (Fig. 2), it can be concluded that no station, with the exception of Dubrovnik, has experienced a significant change in precipitation levels. In eastern Croatia, this trend has stagnated or recorded only insignificant growth. In the remaining parts of Croatia, the trend is either stagnant or dropping. A reduction in the precipitation levels in the observed period is most pronounced in Dubrovnik (65 mm every 10 years), therefore distinguishing this station from all others in Croatia. The station with the second highest drop in precipitation levels in Pazin, with 33 mm every 10 years, while the reduction at other stations has not exceeded 25 mm.

It is also important to note the representativeness of the actual trends. The values of the determination coefficients included in the graph for each station indicate that linear trends are not the ideal choice, i.e. they do not provide the best fit to the annual values. A better fit is achieved using a higher degree polynomial trend line. Such an analysis was conducted, but due to size limitations it is not graphically presented here. It was observed, however, that a sixth degree polynomial trend line fits the moving means quite well, and in some cases to such an extent, given the complexity of the trend, that it could replace the moving means.

Despite this, the linear trend, as one of the fundamental statistic analyses for time series, provides reliable information about the overall changes occurring between the initial and final points of that series, which in this case means the difference in precipitation levels from 1950 to 2007. It is necessary to bear in mind the fact that large differences between years occurred throughout this pemeđugodišnje razlike. Zacijelo bi se mogle očekivati i međusezonske razlike, no to tek valja istražiti.

Stupanj kontinentalnosti je već odavno predmet istraživanja na području Hrvatske (Vujević, 1936). Valja ga razlikovati od određivanja kontinentalnosti ili maritimnosti pluviometrijskih režima (Šegota, 1986). Prema već ranije objašnjenoj formuli izračunat je indeks kontinentalnosti za sve postaje (tab. 1). S obzirom na malu površinu Hrvatske, ne može se očekivati da će indeks kontinentalnosti u Hrvatskoj poprimati drastične razlike. Krajevi u Hrvatskoj koji su pod najjačim klimatskim utjecajima kontinentske mase, imaju indeks kontinentalnosti tek nešto viši od 30%, dok je u najmaritimnijim krajevima taj indeks oko 20%. S takvim vrijednostima cijela Hrvatska je u prijelaznoj maritimnoj zoni.

riod. It is also likely that seasonal differences occurred, and this could be the subject of future research.

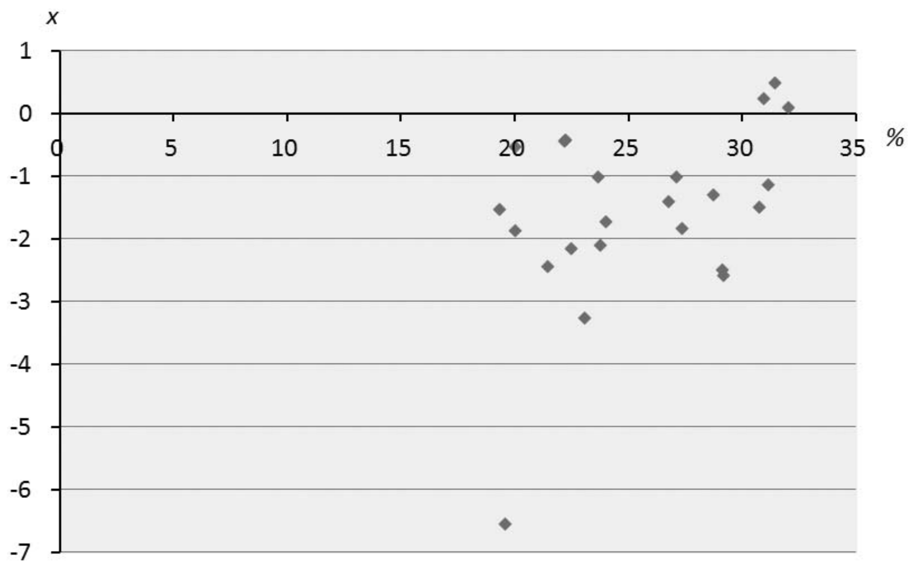
The degree of continentality has long been a subject of research in Croatia (Vujević, 1936). This should be distinguished from the determination of continentality or maritimality based on the pluviometric regimes (Šegota, 1986). Based on the above formula, the continentality index was calculated for all stations (Tab. 1). Considering the small size of the territory of Croatia, it cannot be expected that the continentality index in Croatia will show drastic differences. Areas in Croatia under the strongest climatic influences of the continental mass have a continentality index just over 30%, while in the most maritime areas, the index is about 20%. With such values, the entire country is in a transitional maritime zone.

Tab. 1. Indeks kontinentalnosti (k) za neke postaje u Hrvatskoj
Tab. 1. Continentality index (k) for some stations in Croatia

Postaja/*Station*	*k* (%)	Postaja/*Station*	*k* (%)	Postaja/*Station*	*k* (%)
Osijek	32,00	Karlovac	30,76	Mali Lošinj	20,02
Donji Miholjac	31,44	Ogulin	26,75	Zadar	21,45
Slavonski Brod	30,94	Gospić	27,32	Šibenik	23,74
Bjelovar	30,13	Rovinj	22,48	Split-Marjan	23,63
Križevci	28,70	Pazin	23,04	Hvar	19,98
Koprivnica	29,18	Rijeka	22,17	Lastovo	19,31
Varaždin	29,11	Crikvenica	22,24	Dubrovnik	19,57
Zagreb-Maksimir	27,1	Senj	23,98		

Odnos između jačine linearnih trendova iz sl. 2 i za dotičnu postaju odgovarajućeg indeksa kontinentalnosti iz tab. 1. prvo je ispitan grafički pa je tako dobivena sl. 4.

The relationship between the strength of the linear trends from Fig. 2 and for each station of the corresponding continentality index from Table 1 was tested graphically, and the results are shown in Fig. 4.



Sl. 4. Dijagram rasipanja za vrijednosti jačine trenda (x) i indeksa kontinentalnosti (%).
Fig. 4. Scatterplot for values of the strength of the trend (x) and continentality index (%).

Raspored točaka unutar dijagrama rasipanja pokazuje veliku raspršenost. To znači da se između te dvije varijable ne može očekivati jaka veza. Vizualna ocjena potkrijepljena je izračunavanjem koeficijenta korelacije koji iznosi 0,31 što potvrđuje slabu vezu. Iz toga zaključujemo da je u razdoblju 1950-2007. godine stupanj kontinentalnosti imao minimalno značenje na dugogodišnje trendove količine padalina u Hrvatskoj.

The distribution of points within the scatterplot indicates a wide distribution. This indicates that a strong correlation cannot be expected between these two variables. This visual assessment is corroborated by the calculated correlation coefficient of 0.31, confirming there is only a weak correlation. Therefore, it can be concluded that the degree of continentality had only a minimum influence on the long-term precipitation trends in Croatia in the period 1950–2007.

ZAKLJUČAK

Prema analizi podataka 23 postaje u Hrvatskoj, u razdoblju 1950.-2007. godine količine padalina pokazuju vrlo slabu promjenljivost. Linearni trendovi ukazuju na stagnaciju ili neznatan porast količine padalina u istočnoj Hrvatskoj, dok se istovremeno u ostalim dijelovima Hrvatske bilježi stagnacija ili vrlo blagi pad.

Conradov indeks kontinentalnosti za analizirane postaje iznosi od 19,31% do 32%, pa Hrvatska pripada prijelaznoj maritimnoj zoni.

Stupanj kontinentalnosti nema bitan utjecaj na jačinu dugogodišnjih trendova količine padalina.

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CONCLUSION

According to the analysis of data from 23 weather stations in Croatia for the period 1950–2007, precipitation levels showed very little changeability. The linear trends indicate a stagnation or slight increase in precipitation levels in eastern Croatia, while a stagnation or very slight decrease was recorded for other parts of the country.

The Conrad continentality index ranged from 19.31% to 32% for the investigated stations, placing Croatia in the transitional maritime zone. The degree of continentality had no significant impact on the strength of the long-term precipitation trends.

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SAŽETAK

Proučavanje klimatskih promjena postalo je na globalnoj razini najintrigantniji aspekt klimatoloških istraživanja. Pritom se mnogo veća pozornost pridaje promjenama temperature nego promjenama u količini padalina. Ovaj rad istražuje do kakvih je promjena u količini padalina u Hrvatskoj došlo u razdoblju od 1950. do 2007. god., te utječe li stupanj kontinentalnosti klime na te promjene. Analizirani su podaci 23 postaje. Velike međugodišnje varijacije izglađene su linearnim trendom i primjenom 10-godišnjih kliznih srednjaka. U određivanju stupnja kontinentalnosti primijenjena je formula Gorczyńskog (1920) koju je kasnije preradio Conrad (1946).

U promatranom razdoblju niti na jednoj postaji, osim Dubrovnika, nije došlo do značajnih promjena u količini padalina. Linearni trendovi ukazuju na stagnaciju ili neznatan porast količine padalina u istočnoj Hrvatskoj, dok se istovremeno u ostalim dijelovima Hrvatske bilježi stagnacija ili vrlo blagi pad.

Conradov indeks kontinentalnosti za analizirane postaje iznosi od 19,31% do 32%, pa Hrvatska pripada prijelaznoj maritimnoj zoni.

Koeficijent korelacije od 0,31 između indeksa kontinentalnosti i vrijednosti trenda pokazuje da dugogodišnji trendovi količine padalina ne ovise bitno o kontinentalnosti klime.

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SUMMARY

At the global level, the study of climate change has become the most intriguing aspect of climatology research. Much more attention has been focused on changing temperatures than on changing precipitation levels. This paper investigates whether precipitation levels in Croatia have changed in the period from 1950 to 2007, and whether the degree of continentality has influenced those changes. Data from 23 weather stations were analysed. The high variation between years was reduced using linear trend lines and ten-year moving means. In determining the degree of continentality, the Gorczyński (1920) formula, as adapted by Conrad (1946) was applied.

In the observed period, no significant changes in precipitation levels occurred at any stations, with the exception of Dubrovnik. The linear trends indicate a stagnation or slight increase in precipitation levels in eastern Croatia, while a stagnation or very slight drop in levels was recorded for the rest of the country.

The Conrad continentality index ranged from 19.31% to 32% for the observed stations, indicating that Croatia belongs to the transitional maritime zone.

A correlation coefficient of 0.31 between the continentality index and trend values indicates that the long-term precipitation levels do not significantly depend on the continentality of the climate.

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