



DROUGHT MONITORING IN CROATIA

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overview

- Introduction
- Drought monitoring
- Final remarks
 - current activities and future work









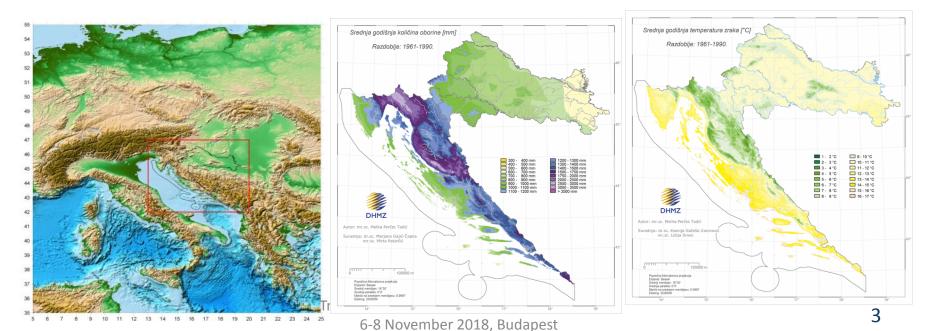
Drought 2012 in Croatia [source DHMZ Bulletin]

Introduction

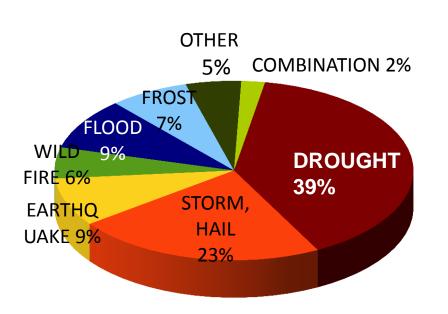
Climate of Croatia

- determined by its specific geographical position
- modifiers: the Adriatic and the Mediterranean, the Dinarides, openness to the Pannonian plain (NE region)...

http://klima.hr/razno/publikacije/klimatski_atlas_hrvatske.pdf



Economic losses from damages caused by *natural hazards* in Croatia (1981-2012)



During extremely dry years (2000,2003,2007,2011/2012) losses ranged from 70% to 90% (Cindrić et al. 2014)

Agriculture sector is the most vulnerable: large yield losses, up to complete damage



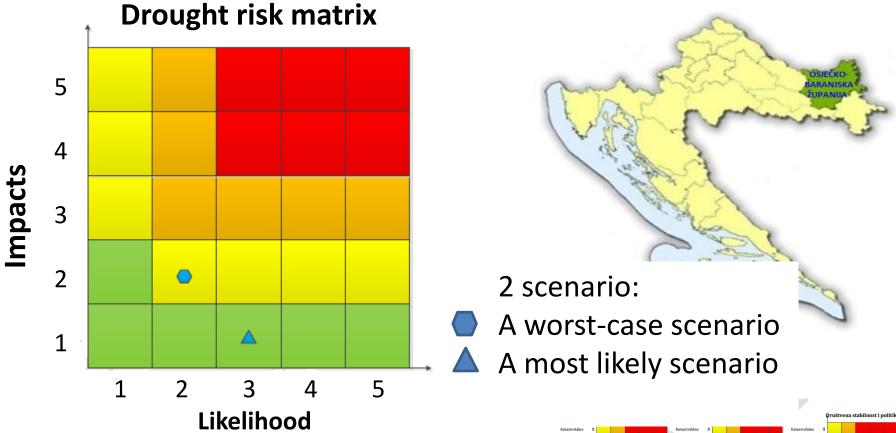
Drought 2017, Korčula island, Croatia

Drought risk – included in Disaster Risk
 Assessment in Croatia (2015)

- Coordinated by National Protection and Rescue Directorate with many governmental institutions particapation (including DHMZ)
- plant diseases, animal diseases, extreme temperatures, epidemics and pandemics, industrial accidents, floods, fire, earthquake, snow and ice, drought, saltwater intrusion

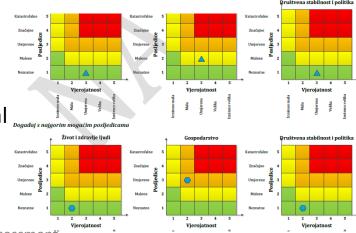
Risk Assessment and Mapping Guidelines for Disaster Management EC (2010)

http://www.platforma.hr/images/dokumenti/Zavrsni_sazetak_2 015_11.pdf



- (1) limited/insignificant
- (2) minor/ substantial
- (3) moderate/ serious
- (4) significant/ very serious
- (5) catastrophic/ disastrous

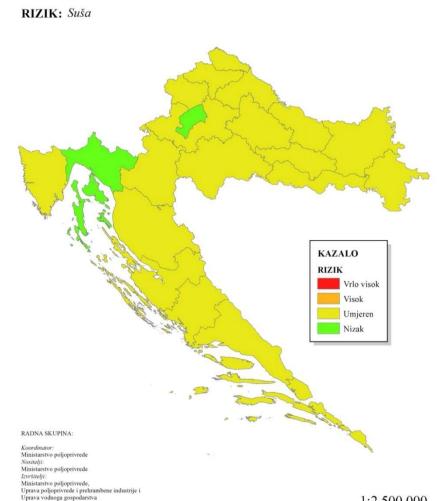
Impacts:
human
economic/environmental
political/social



Training course on drought risk assessment 6-8 November 2018, Budapest



PROCJENA RIZIKA OD KATASTROFA U REPUBLICI HRVATSKOJ



Državni hidrometeorološki zavod (DHMZ)

DROUGHT RISK MAP OF CROATIA

- Moderate risk prevails

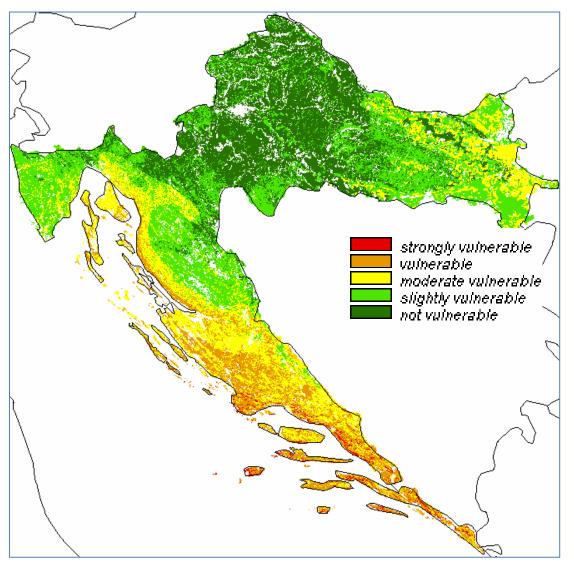
Large uncertainity!

Tablica 6.10.-19. - Nepouzdanost rezultata procjene rizika

	Ne postoji dovoljna količina statističkih podataka, iskustva stručnjaka i ostalih podataka te pouzdana metodologija procjene posljedica zbog čega se očekuju značajnije greške.		
Vrlo visoka nepouzdanost	4		
Visoka nepouzdanost	3	X	
Niska nepouzdanost	2		
Vrlo niska nepouzdanost	1		
	Postoji dovoljna ko	Postoji dovoljna količina statističkih podataka, iskustva stručnjaka i	
	pouzdana metodolog	pouzdana metodologija procjene zbog čega je pojavljivanje grešaka vrlo	
	malo vjerojatna.		

1:2.500.000

Drought vulnerability map in Croatia



Combination of slope map, solar irradiation, precipitation Cv, soil types and land cover classes

Southern Adriatic and Eastern lowland – most sensitive to drought

- first version
- improve e.g. economic losses

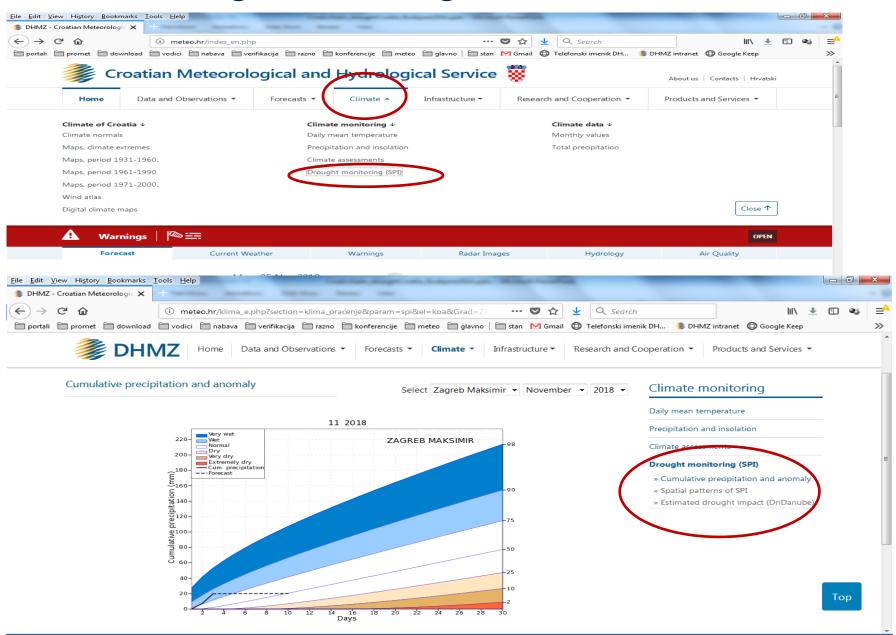
Perčec Tadić et al. (ACS, 2014)

Drought monitoring

- an increasing interest in developing methods for drought warning system in Croatia
- Comprehensive drought early warning system should provide (Hayes et al., 2011):
 - drought monitoring
 - an early warning of drought *onset* and it's *intensity* in timely manner
 - drought *prediction* compoment
 (to protect crops, fire risk, water supply...)

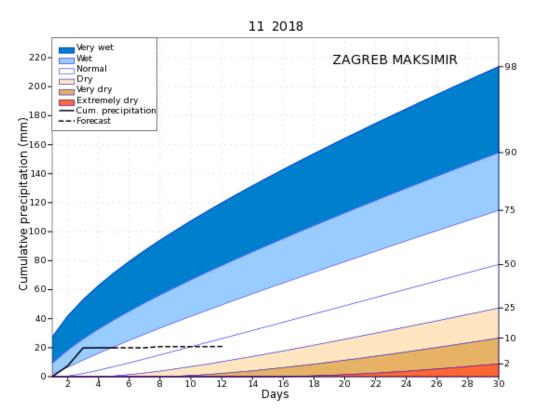
DHMZ - drought monitoring

http://meteo.hr



daily scale:

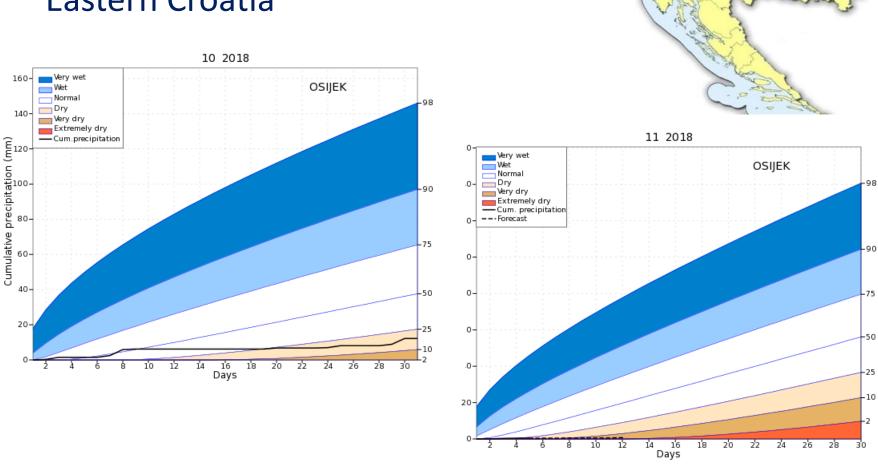
- Cumulative precipitation amounts up to the date
- With 7-days ECMWF forecast



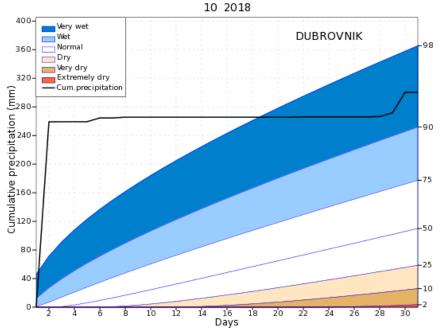
'Peacock tail'
Theoretical percentiles
(Juras, TAAC 1994;
Cindrić et al., TAAC 2018)
- Daily updated!

Cumulative precipitation amount (mm) in November 2018 and theoretical percentiles (2nd, 10th, 25th, 50th, 75th, 90th and 98th) curves from the period 1961-2000

Eastern Croatia



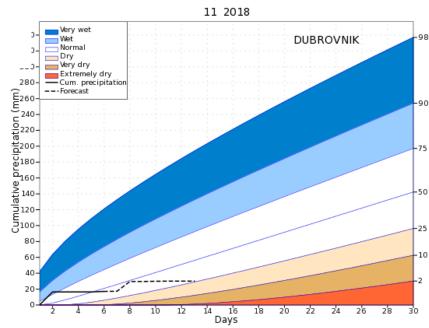
Cumulative precipitation amount (mm) in November 2018 and theoretical percentiles (2nd, 10th, 25th, 50th, 75th, 90th and 98th) curves from the period 1961-2000

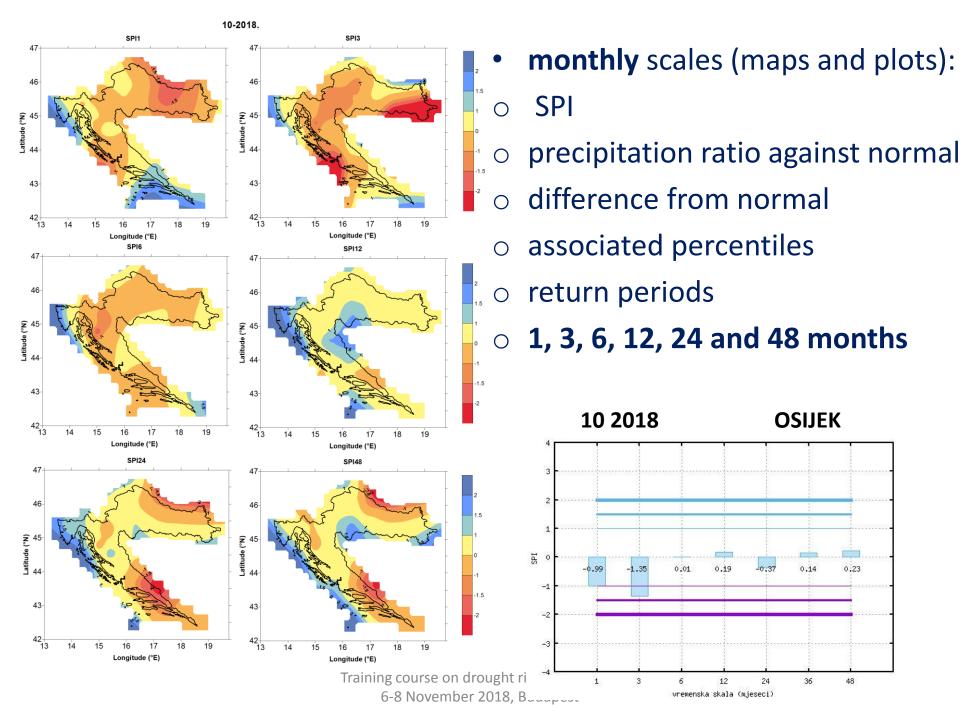


Source: Grgo Jelavic/PIXSELL

Southern Adriatic Dubrovnik station

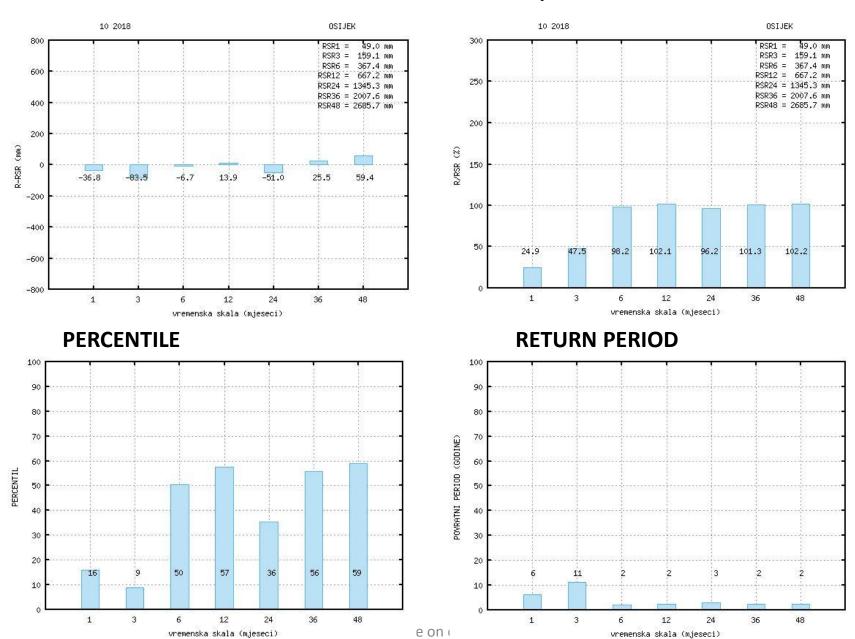
Extremely wet October In 3hrs – 259 mm





R - RMEAN

R / RMEAN



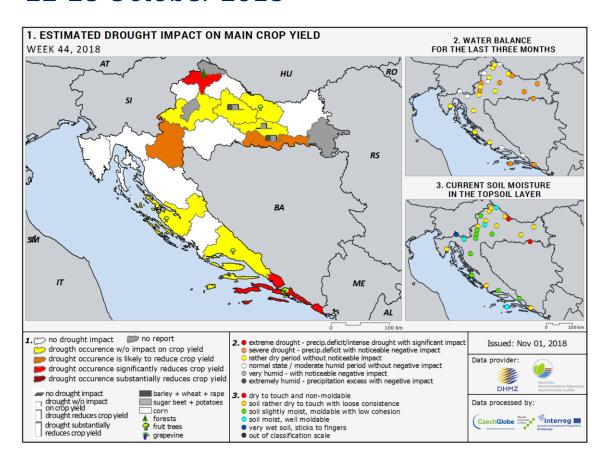
6-8 November 2018, Budapest

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Maps of estimated drought impact on crop yield, fruits, viticulture, olives and forest - Croatia



22-28 October 2018



Maps are created according to the questionnaires fulfilled by reporters once a week, always at the same location.

Reporting is a part of the activities within DriDanube project.

40 repoters

Croatian Agricultural and
Forestry Advisory Service

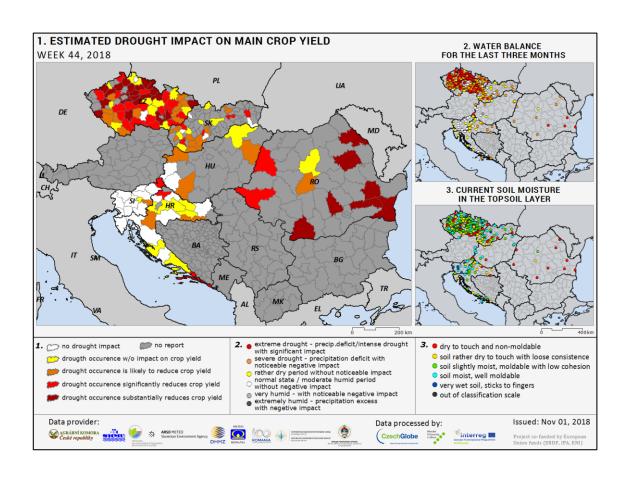
DHMZ

Others

Maps of estimated drought impact on crop yield, fruits, viticulture, olives and forest - Danube region Danube Transnational Programme



22-28 October 2018



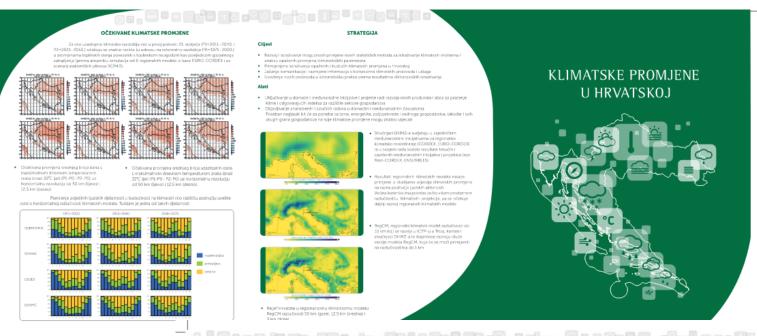
Drought monitoring

DHMZ monthly bulletin (in Croatian)

- few months delay
- meteorological and climate detailed analysis
- dry/wet spells analysis, SPI
- extreme weather impacts from newspapers



CLIMATE CHANGE IN CROATIA - BROCHURE



of . [2 - p 25] p . [3 | p . [4 | p . 2] p . [4 | p . 2] p . [5 | p . [6 | p . 2] p . [6 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | p . 2] p . [7 | OPAŽENE KLIMATSKE PROMJENE **OPAŽENE KLIMATSKE PROMJENE** ISTRAŽIVANJA KLIME IL HRVATSKOJ Klimatski atlas Hrvatske 1961-1990, 1971-2000. ema su medu navažrašm parametnima Predstavlja fundamentolni doprinos za upoznavanje prirodnih karakteristika Hrvatske i njezina klimatskoga gredżeljstva, vodnoga grupostarstva, murgotka, poljodjetatva, fuziona, zdvastva, sporta, zakide okolika. · grafikone goditnih hodova mnogih parametan klimatekin ellemenata na deset odabranih meteoroloilkin postase Trendovi ptrovinskim parametara u razdobiju 1961-2010. pokazuju: tablice s prosječnim 30-goditnjim mjeso god śnja kościna opcine (Ri śmanjuje se duż Jadrana ponspiże zoog znazna smanjenja (ad 1334), a u protecta (MANI) na spiremom Jadranu, a povedava se u istočnoj Siavoniji u jesemkim mjerecima (SON). pozitivni i sve veći trendovi anomalija srednje temperature prako te broja toplih dana šnije prikazanol i toplih noći: Vrste analiza klimatskih promjena od početka 20. doljeća najveći dopinos ponatki temperature u kominientalnomu dijelu zemije doju zimske, a na obad ljutne temperature zrako; podpatnjih 50 gosina i u kontinentalnomu dijelu najveće je zatopljenje ijeli u jsave. za lukacije referentne za područja kontinentalne, gorske i maritimne hrvatske klime. OČEKIVANE KLIMATSKE PROMJENE Sang nanje odstupenja srednje godilnje temperature zrako u nazdobiju 1901–2015 od srednjaka za 1961–1990. polsazuje da je, kao posljedicu ubrzanog zisprjevanja atmosfere od levja 20. stojeća, 15 najosefa pod na zabečevno u posljednja dva desetljeća, a čak 13 najosplijn godina od 2000. godine razdoble analiza: od sredine 20. stoleća. Projekcije buduće klime pomoću alobalnih i regionalnih klimatskih modela. #Ministria razdobija. referentno razdobije. PO - 1961 - 1990. W 1971 - 2000. biuduća in o primjest. početak 21. sroljeća. P2 - 2011 - 2040. srolj 21. sroljeća. P2 - 2041 - 2070. rolj 21. sroljeća. P3 - 2071 - 2070. Globalni filimatski modeli sastavljeni su od modela atimosfere, oceana, tia, vegetacije i leda te imaju i obuhvaćene civluse statilem čalh pi inova simuliniu komponente kilmatskota sustava i nilhovo međudelovanje, obuhvačanjem izmierenih koncentracija stakleničkih plinova se njihovih scenarija za 21. stoljeće za manja područja daju nezadovoljavajuće priazce retera i rezultave simulacija prizemnih klimatskih

Current work and future plans

- implement the SPEI
- to use satellite data DriDanube project
- operational forecast of SPI in DHMZ
- modelling dry spells by extreme value theory
 (Pasarić & Cindrić 2018; Cindrić & Pasarić 2018)
- to increase synergy among meteorology, <u>hydrology</u> and <u>agronomy</u>
- additional national efforts should be made in drought risk assessment in Croatia - DriDanube project

Thank you!

http://meteo.hr

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Perčec-Tadić M, Gajić-Čapka M, Zaninović K, Cindrić K (2014) Drought vulnerability in Croatia. *Agriculturae Conspectus Scientificus* Vol. 79 (2014) No. 1 (31-38)

Cindrić K, Telišman-Prtenjak M, Herceg-Bulić I, Mihajlović D, Pasarić Z (2014) Analysis of the extraordinary 2011/2012 drought in Croatia. *Theoretical and Applied Climatology*, Vol. 123, Issue 3-4, pp. 503-522

Cindrić K, Juras J, Pasarić Z (2018) On precipitation monitoring with theoretical statistical distributions. *Theoretical and Applied Climatology*, DOI: 10.1007/s00704-018-2477-6

Pasarić Z, Cindrić K (2018) Generalised Pareto distribution: impact of rounding on parameter estimation. *Theoretical and Applied Climatology* DOI: 10.1007/s00704-018-2494-5

Cindrić K, Pasarić Z (2018) Modelling Dry Spells by Extreme Value Distribution with Bayesian Inference. *Pure and Applied Geophys*ics DOI: 10.1007/s00024-018-2007-6