# SURFACE ENERGY BALANCE

## QUICK ASSESSMENT USING
## GENERAL SYSTEMS THEORY
## AND
## CLIMATIC ENERGY BALANCE DIAGRAM

### METHOD -> ANALYSIS -> FINDIGS -> PROPOSALS

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Beyond the Climate Change Consensus
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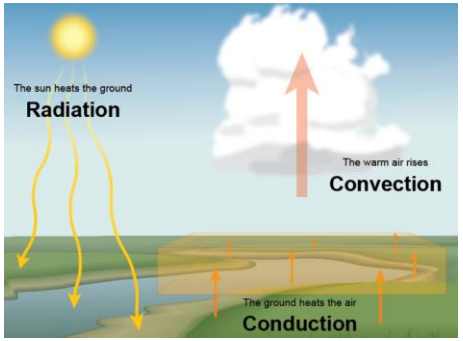
BUDAPESTI MŰSZAKI
ÉS GAZDASÁGTUDOMÁNYI EGYETEM
Építőmérnöki Kar - építőmérnöki képzés 1782 óta
Vízépítési és Vízgazdálkodási Tanszék

# 1. BASICS: FROM THE SCOOL / MIT HOZUNK AZ ISKOLÁBÓL?

## BOTTOM UP WARMING OF THE AIR / A LEVELGŐ FELMELEGEDÉSE ALULRÓL

### 3. Science and technology / tudomány és technológia




https://www.noaa.gov/jetstream/atmosphere/transfer-of-heat-energy

### 2. secondary school: graduation exam / földrajz érettségi tétel

**A levegő felmelegedése**

FÖLDRAJZ ÉRETTSÉGI TÉTELEK

– a napsugárzás csaknem fele éri el a Föld felszínét, a többi visszaverődik

– a földfelszín elnyeli a napsugarakat és hővé alakítja

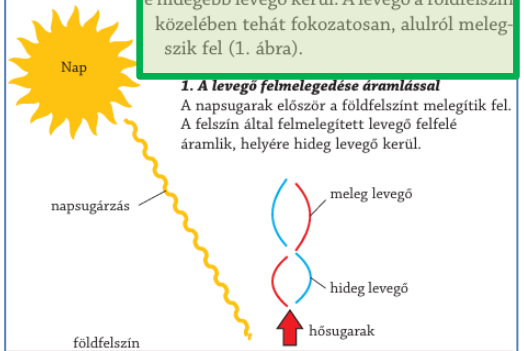
– a Nap a földfelszín közvetítésével alulról melegíti fel a levegőt

– felfelé a hőmérséklet csökken

https://erettsegi.org/a-levego-felmelegedese.html

### 1. primary school curriculum / általános iskolai tananyag

A napsugárzás keresztülhalad a légkörön, és először a földfelszínt melegíti fel. A felmelegedett felszín az elnyelt hő egy részét **kisugározza**, átadja a felette elhelyezkedő levegőrétegnek. A **hőáramlás** során a magasabb hőmérsékletű levegő felfelé áramlik, helyére hidegebb levegő kerül. A levegő a földfelszín közelében tehát fokozatosan, alulról melegszik fel (1. ábra).

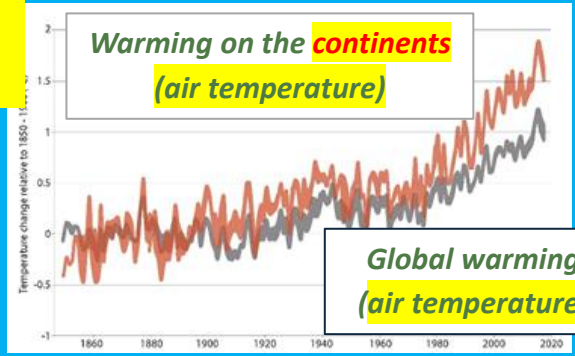



***1. A levegő felmelegedése áramlással***
A napsugarak először a földfelszínt melegítik fel. A felszín által felmelegített levegő felfelé áramlik, helyére hideg levegő kerül.

https://ofi.oh.gov.hu/sites/default/files/attachments/termeszetismeret_6_1.pdf

?

**Q: Why do continents (the air) warm faster?**

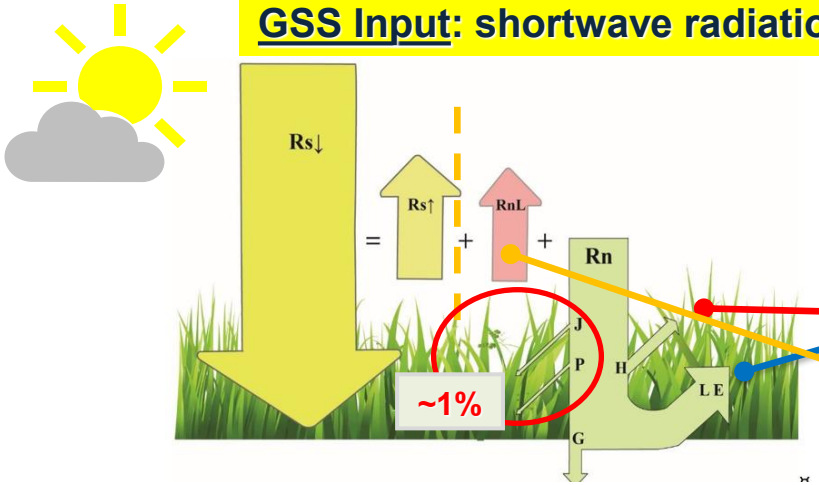



IPCC, 2019: Climate change and Land

# 2a. **Functional analysis** of the energy distribution system, and **Changes** between 1961-1990 and 1991-2020 in the Danube-basin

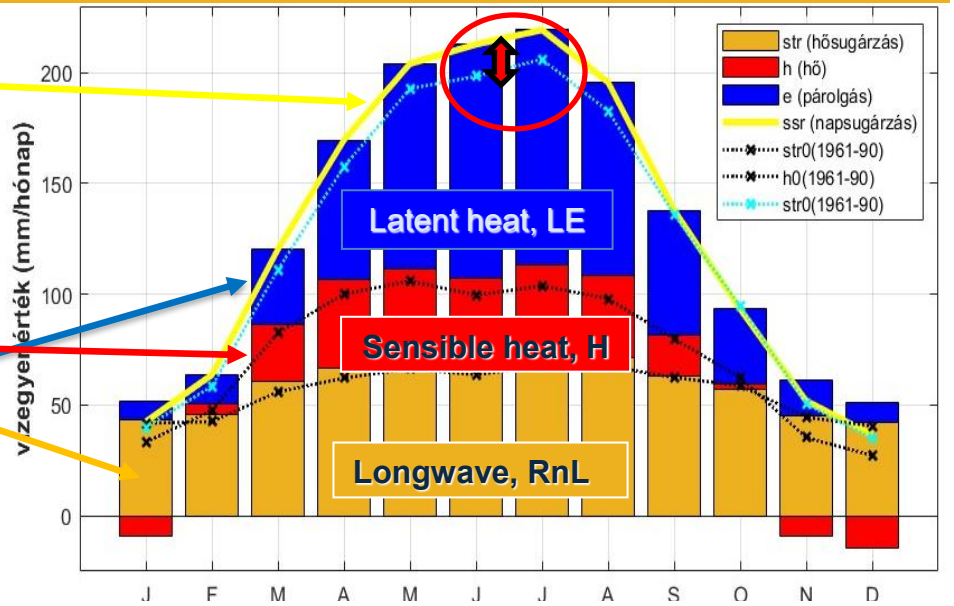
**SURFACE ENERGY BALANCE: INPUT = OUTPUT**
UNIT OF MEASURE: WATER EQUIVALENT OF ENERGY (WITH HEAT OF VAPORIZATION

**GSS Input: shortwave radiation**




Main components of the surface energy distribution process, (Ryplová et al., 2022)

**GSS Output: transformation to other energy forms**

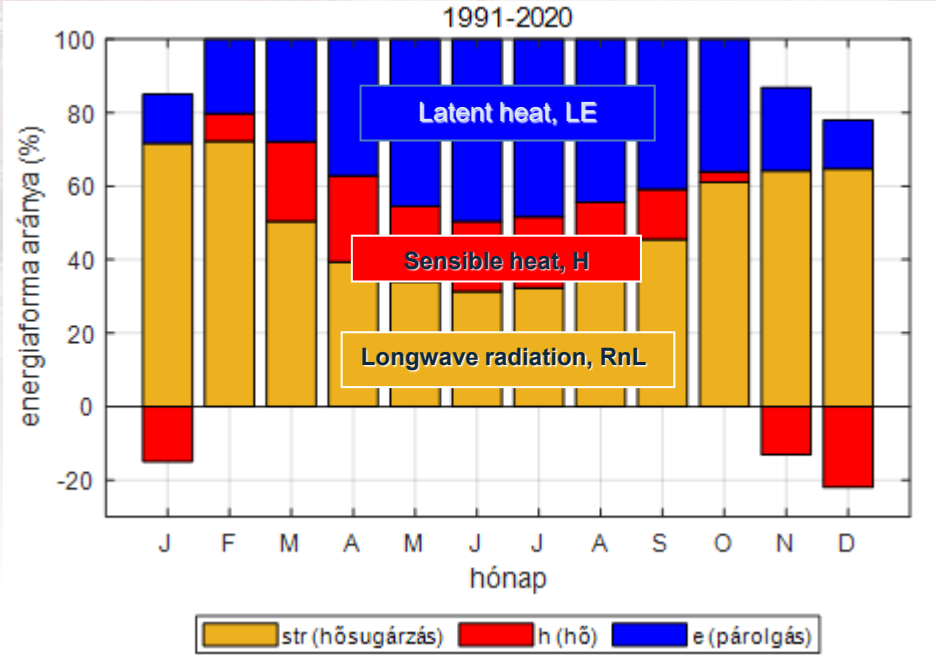



Monthly average of output energy forms in 1991-2020 (bars) compared to 1961-1990 (lines)
Data: ERA5-Land (Muñoz, 2019), chart: Báder, 2025b

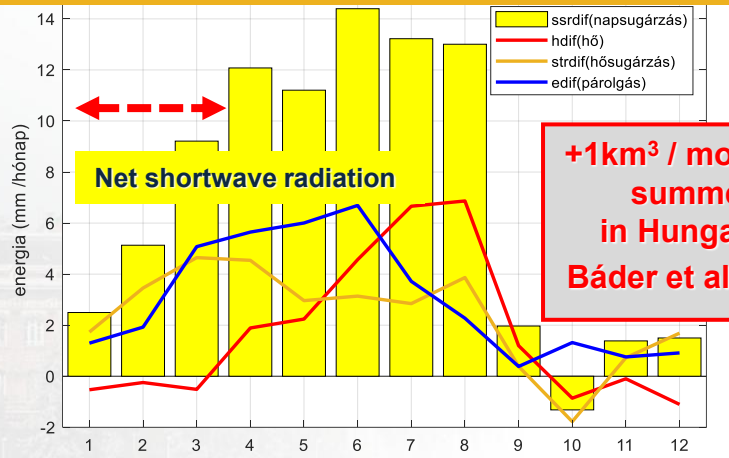
Framework: Earth System and key subsystems via General Systems Theory (L.v.Bertalanffy)

# 2b. Findings: Changes btw. 1961-1990 and 1991-2020

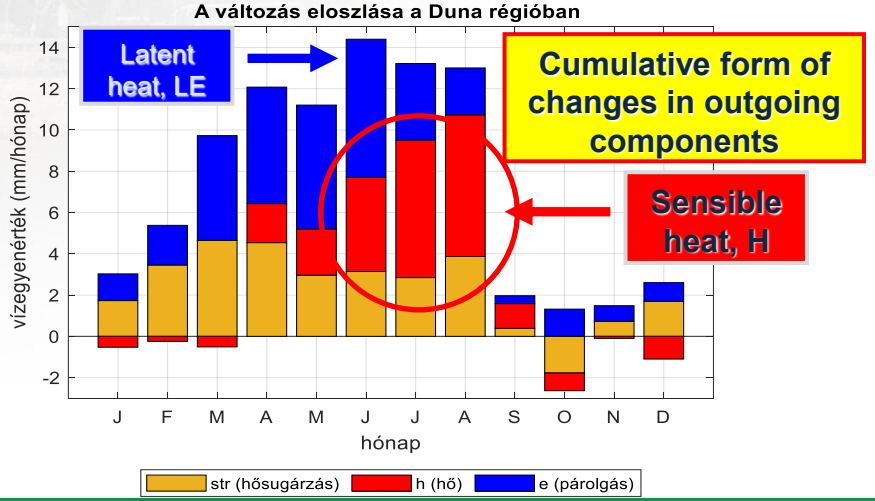
## Ratio of the monthly outgoing energy forms (%)




## Changes in monthly outgoing energy forms (mm)




+1km³ / month in summer in Hungary !
Báder et al. 2023



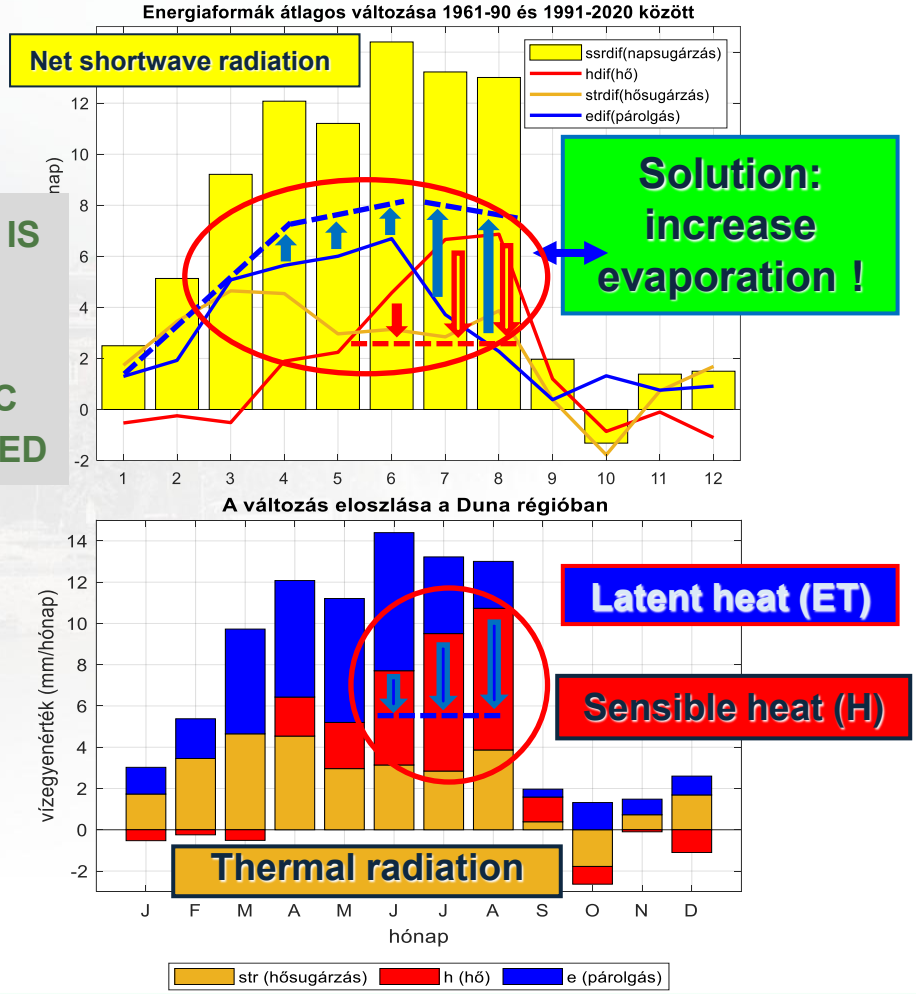

Cumulative form of changes in outgoing components

Sensible heat, H

# 3. Problem statement and proposed action

**The system will be exhausted by July, there is not enough médium for heat transfer! (Báder et al. 2023)**

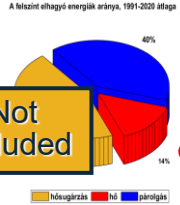
**The importance of evaporation in the climatic energy distribution process is underestimated**

# 4a: Proposed Tool: Climatic Energy Balance Diagram (CEBD) to show main components (ET and H) and highlight changes (Báder, 2025a)

Annual ratios

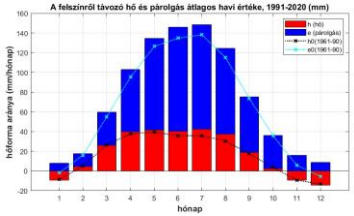
**Latent heat,**



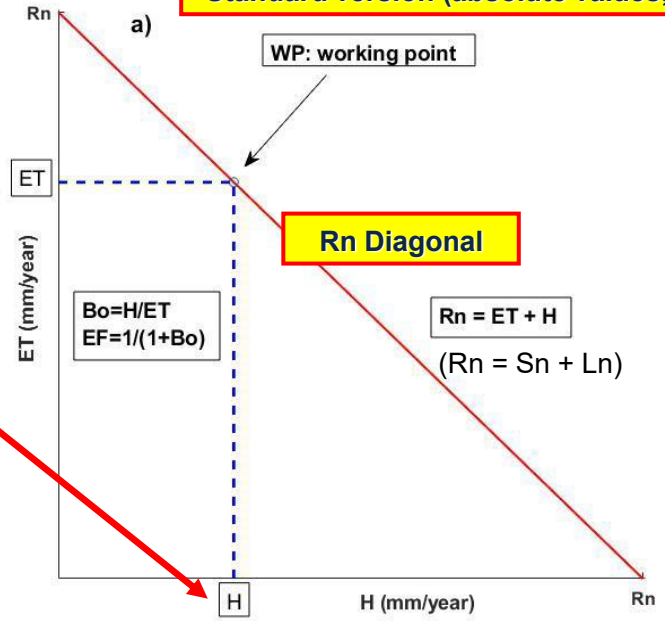

Not included

**Sensible heat, H**

Monthly breakdown

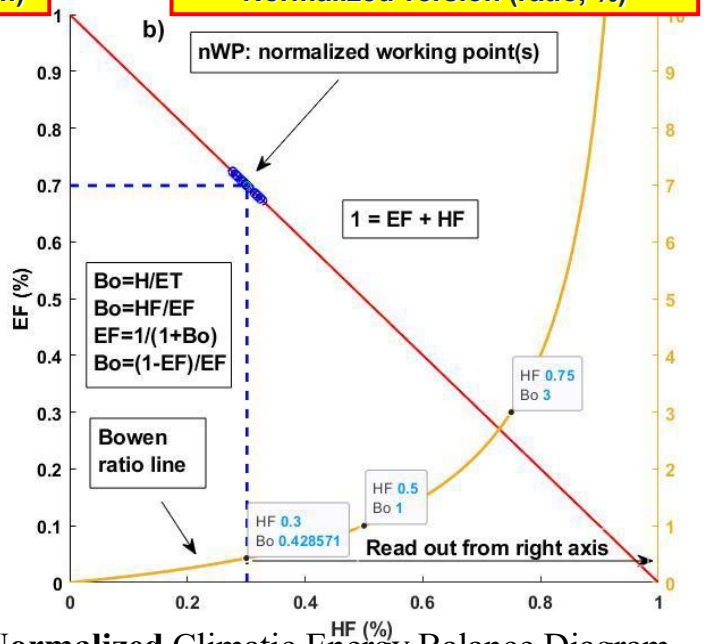



**Standard version (absolute values, mm)**




Climatic Energy Balance Diagram (CEBD)

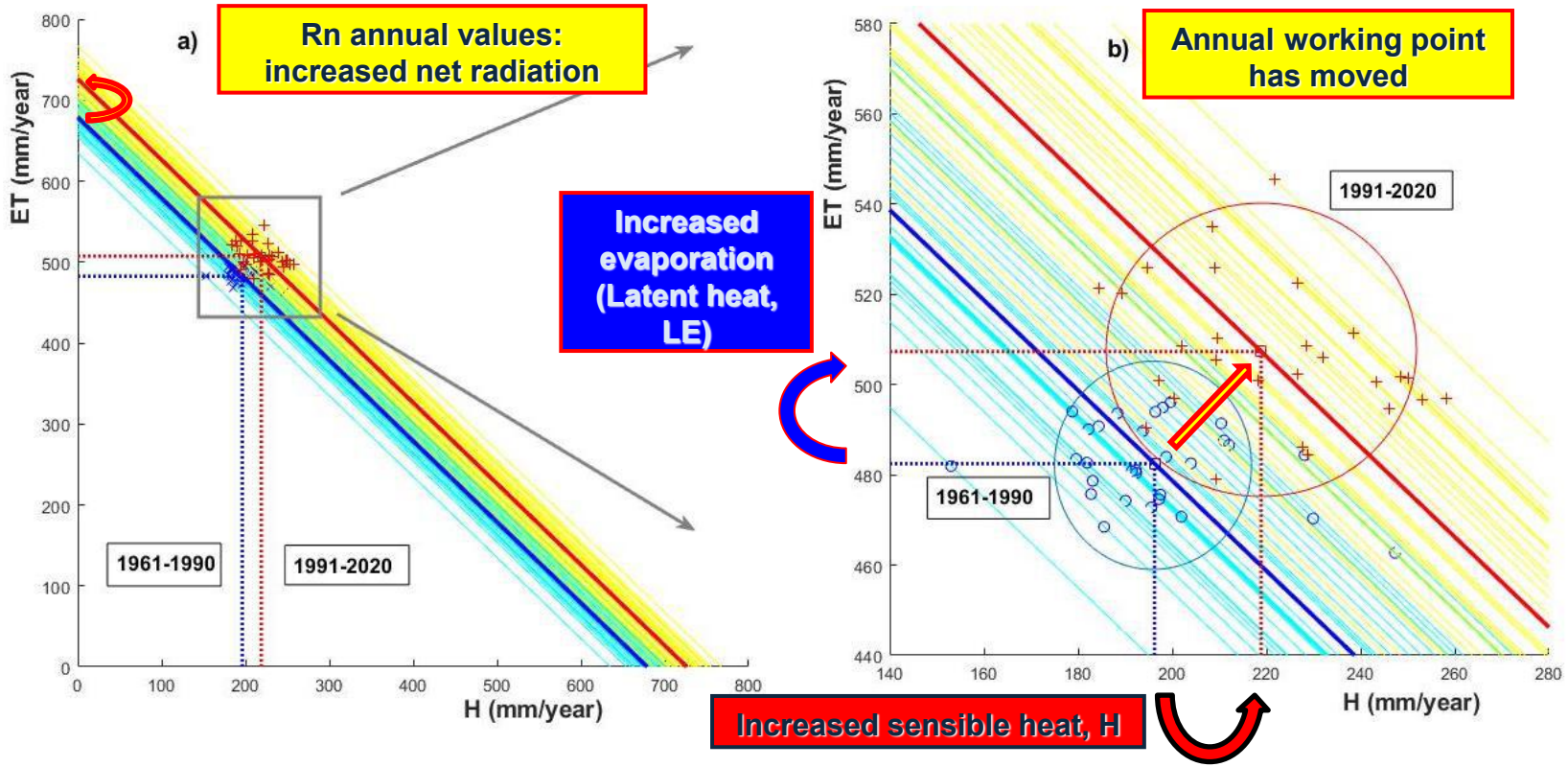
**Normalized version (ratio, %)**




**Normalized** Climatic Energy Balance Diagram.
Left axis: evaporative fraction.
Right axis: Bowen ratio.

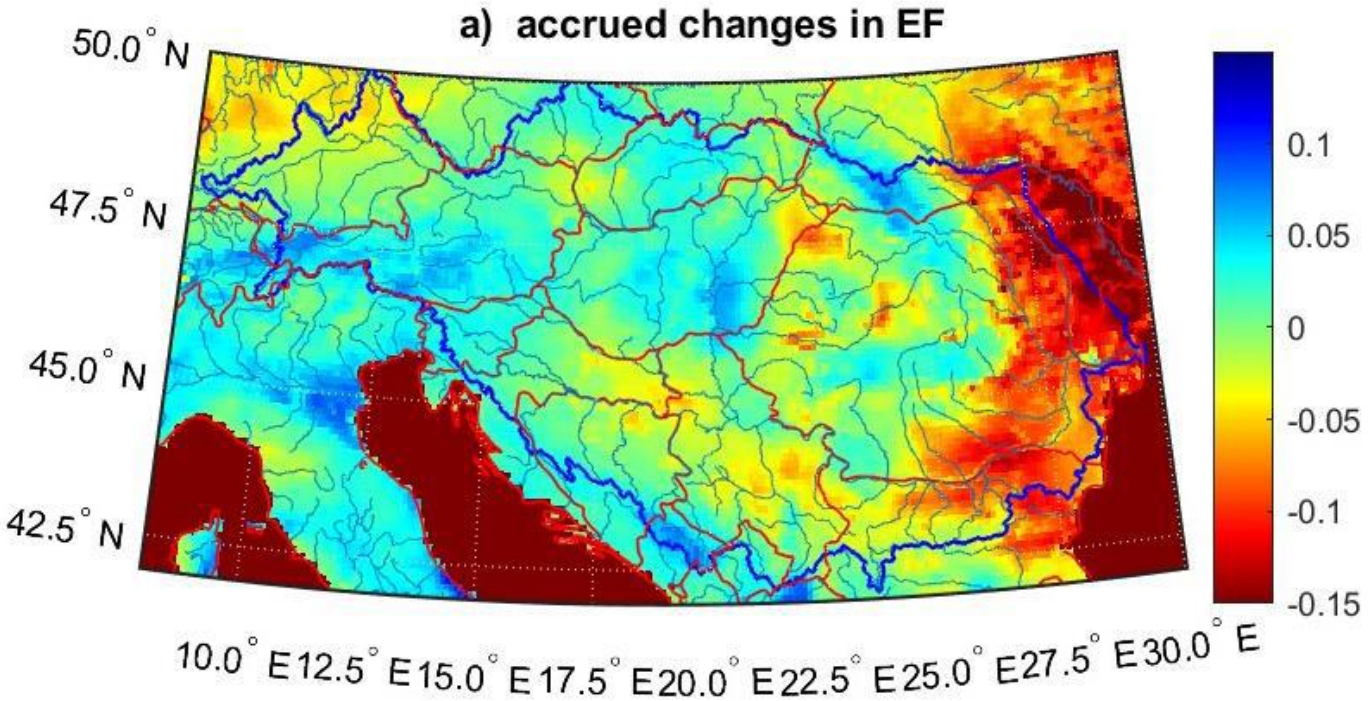
**All energy data are converted to water equivalent (mm evaporation/month)**

# 4.b Climatic Energy Balance Diagram for the Danube-basin with changes shown from 1961-1990 to 1991-2020



# 5a. Proposed indicator: Evaporation fraction, EF (ET/Rn)

## Example: EF <u>trends</u> in the Danube-basin between 1991 and 2020




„Wet is becoming wetter, dry is becoming drier" (Putnam & Broecker 2017)

(fig.: Báder, L., 2025a)

# Thank you for your attention !


*The research was funded by the Sustainable Development and Technologies National Programme of the Hungarian Academy of Sciences (FFT NP FTA).*

*Subproject: Sutainable Water Resource Management*

# References

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