

Climate Change in the Eastern Mediterranean: Challenges for Coastal Cities

Manfred A. Lange

**Director, Future Earth MENA Regional Center
The Cyprus Institute, Nicosia, Cyprus**

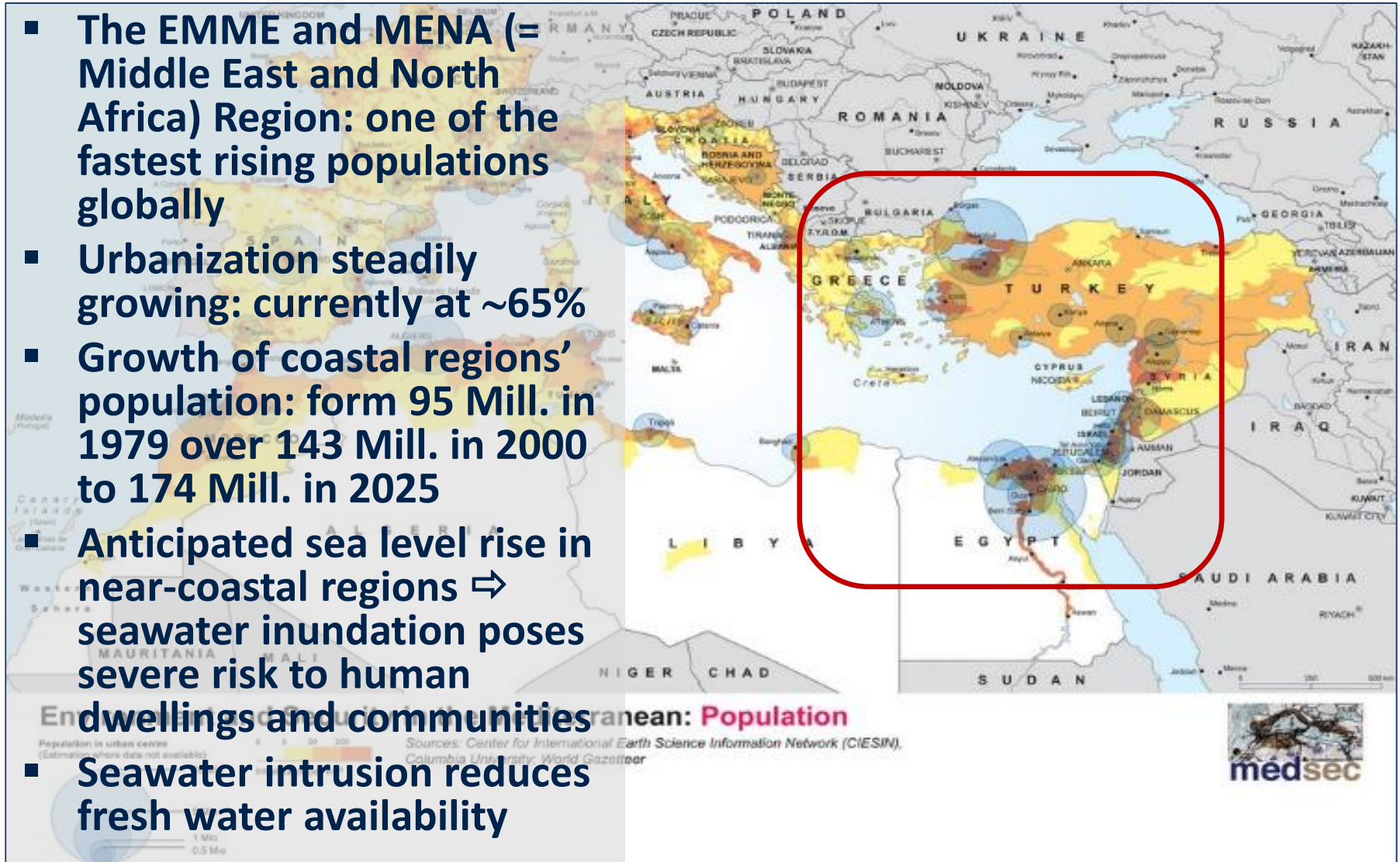
Ilya Varlamov | zyalt.livejournal.com | 28-300.ru Photo Agency

EMME Region: Characteristics and Challenges

- Climatic changes above global means ⇒ significant impacts
- The Eastern Mediterranean and Middle Eastern Region (EMME Region): population **> 400 million – and growing**
- **Increasing urbanization** and growth of illegal dwellings as well as significant societal gradients ⇒ violent unrests and upheavals
- **Multiple pressures** on water supply, energy generation, food security and environmental integrity
- Though sharing common characteristics (religious beliefs, language), **EMME/MENA countries are distinctly different**
- Significant political and societal transformations, armed conflicts, significant (forced) relocation and growing refugee communities ⇒ **challenges to sustainable future of the region**

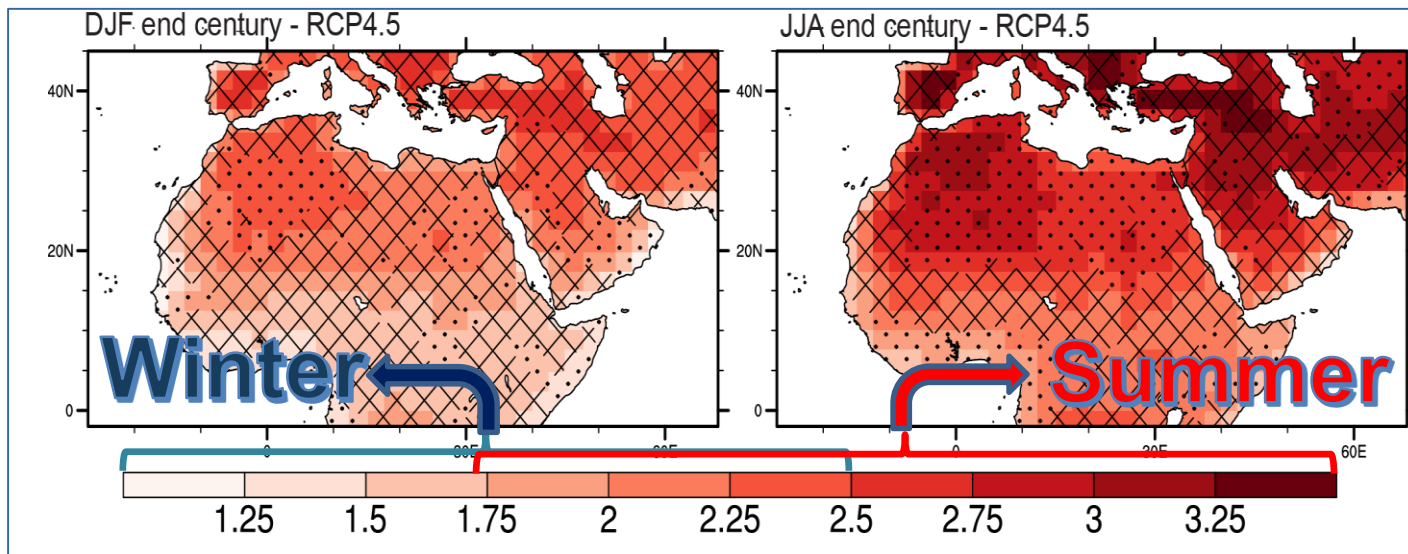
EMME Region: Urban Centers

- The EMME and MENA (= Middle East and North Africa) Region: one of the fastest rising populations globally
- Urbanization steadily growing: currently at ~65%
- Growth of coastal regions' population: from 95 Mill. in 1979 over 143 Mill. in 2000 to 174 Mill. in 2025
- Anticipated sea level rise in near-coastal regions ⇒ seawater inundation poses severe risk to human dwellings and communities
- Seawater intrusion reduces fresh water availability



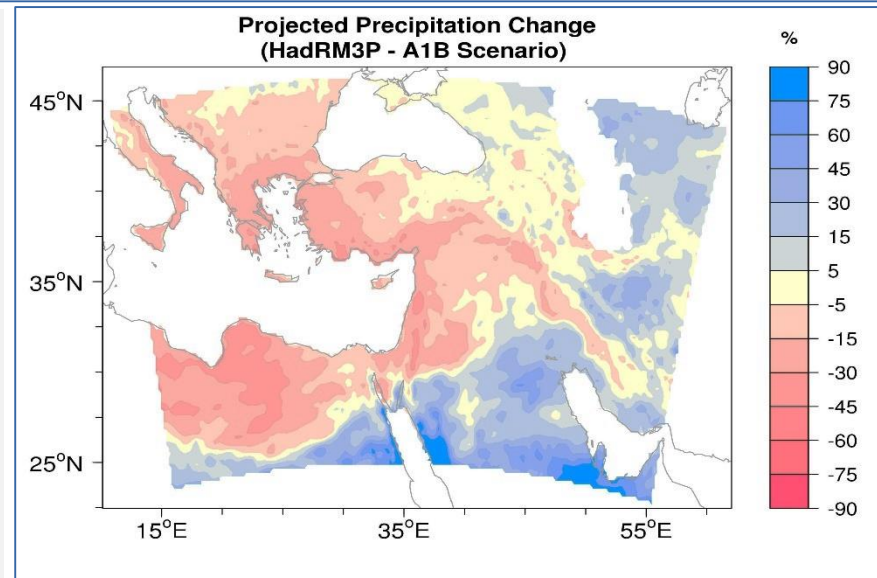
EMME Region: Climate Change

- **Climate Change: higher than global averages**
- **Hotter summers, milder winters**
- **Reduced precipitation, extended droughts**



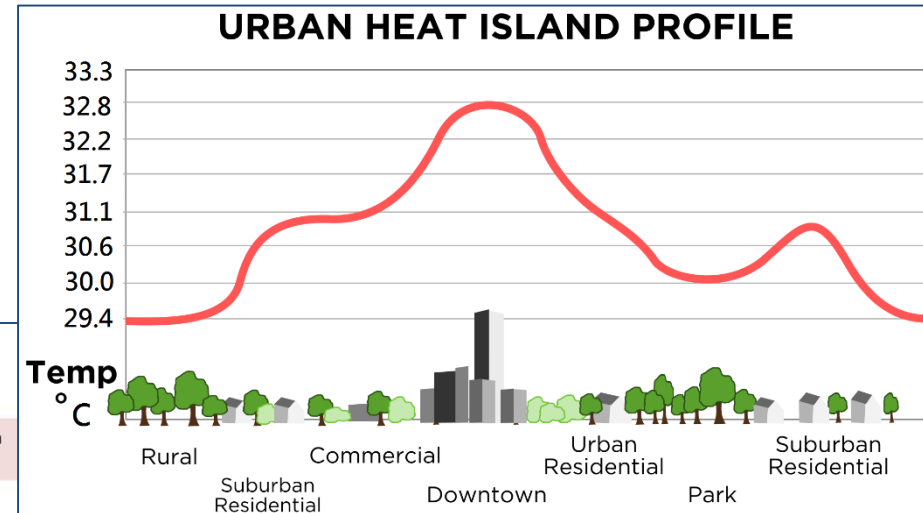
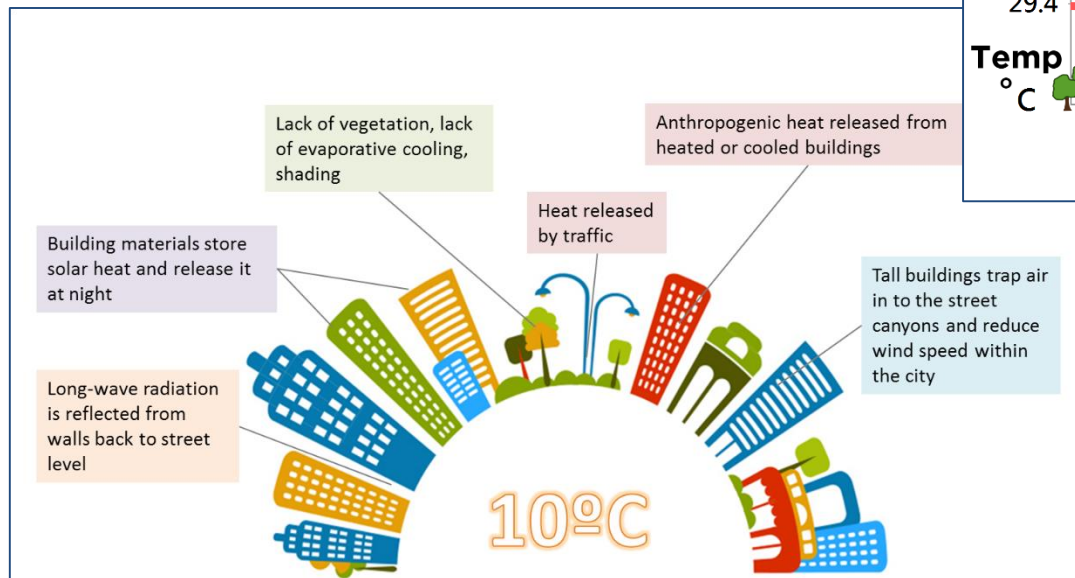
Changes in end-century near-surface temperature in degrees K during Dec, Jan, Feb (DJF) and Jun, Jul, Aug (JJA) according to the RCP4.5 emission scenarios; source: Lelieveld et al., 2016 (above)

Changes in end-century precipitation according to the A1B emission scenarios, source: Zittis et al., 2015 (right)



Urban Warming

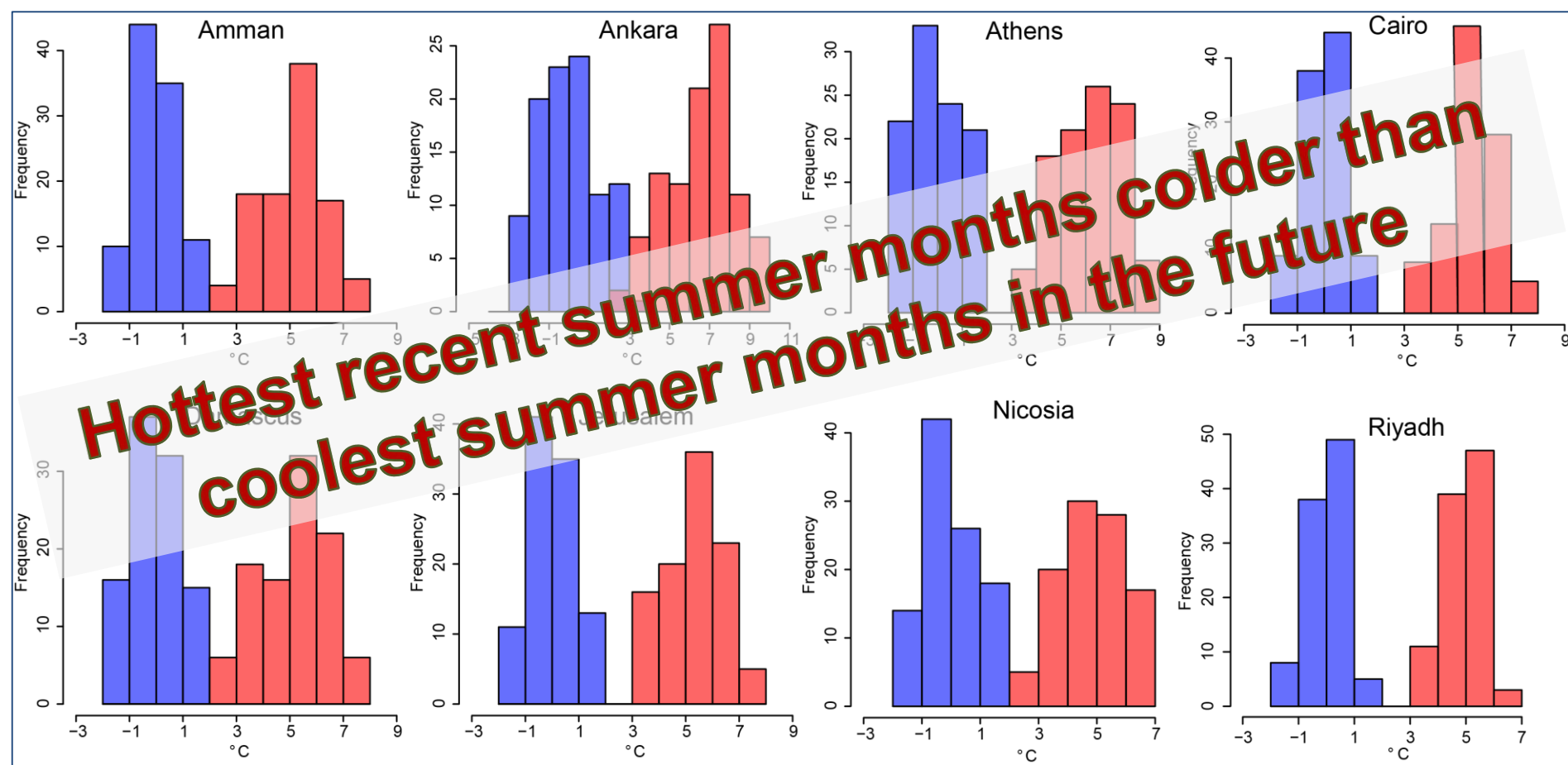
- Urban areas are heating up more strongly than surrounding rural areas: urban heat island effect
- There are numerous factors contributing to this effect



Schematic near-surface temperature profile over urban and adjacent rural areas (above); some of the factors contributing to the urban heat island effect (left); source: <http://tunza.eco-generation.org/ambassadorReportView.jsp?viewID=43398>

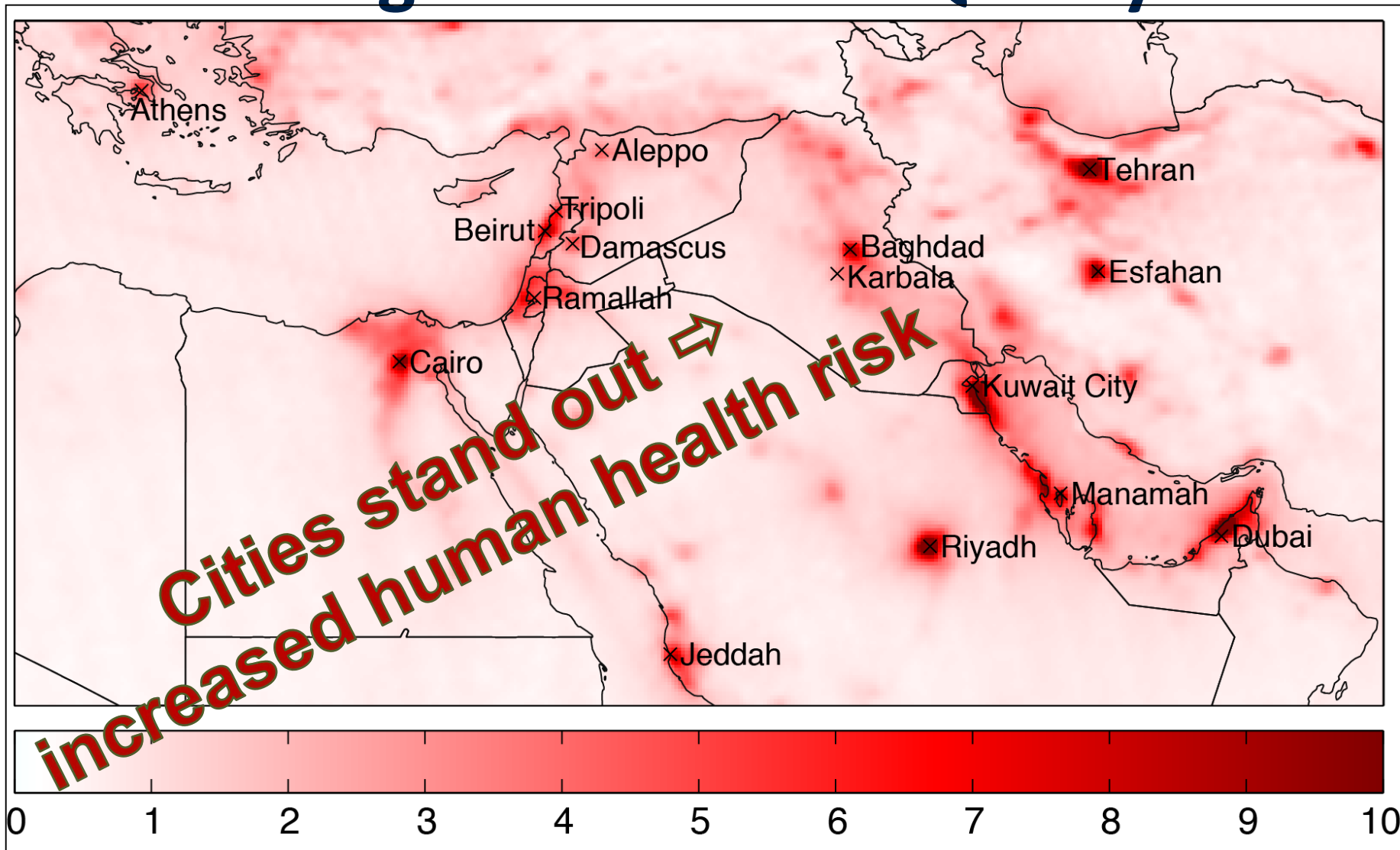
EMME Region: Urban Warming

- Regional climate model results: enhanced urban heating



Frequencies of summer (JJA) maximum temperature anomalies (%). Blue is the reference period 1961-1990 (centered around 0°C) and red 2070-2099, indicating strongly increasing hot periods; source: Lelieveld et al., 2014

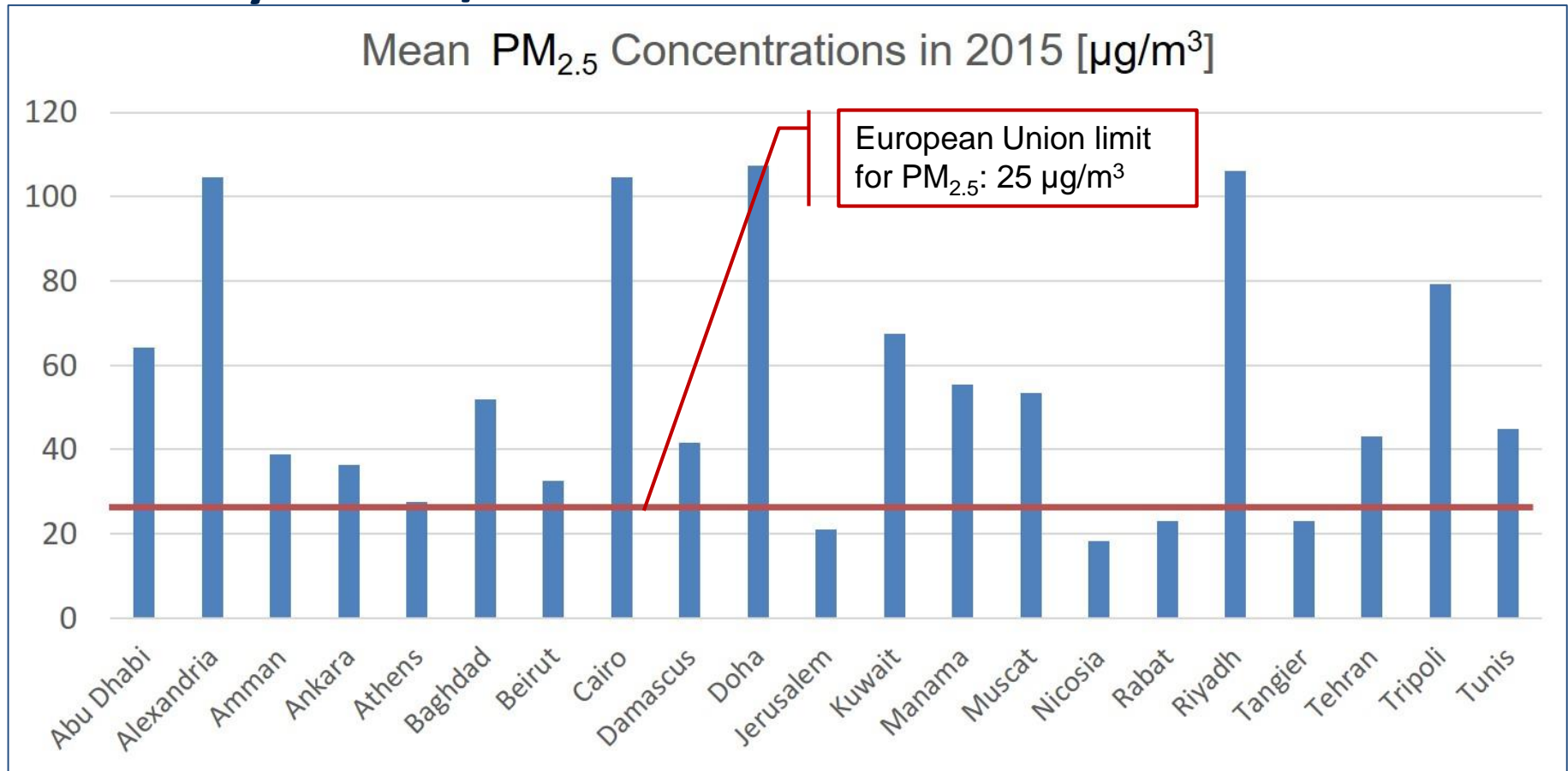
EMME Region: Urban Air Quality



NO₂ column densities in 10¹⁵ molecules/cm² observed by OMI over 2005 – 2014 ; source: Lelieveld, pers. comm.

EMME Region: Urban Air Quality

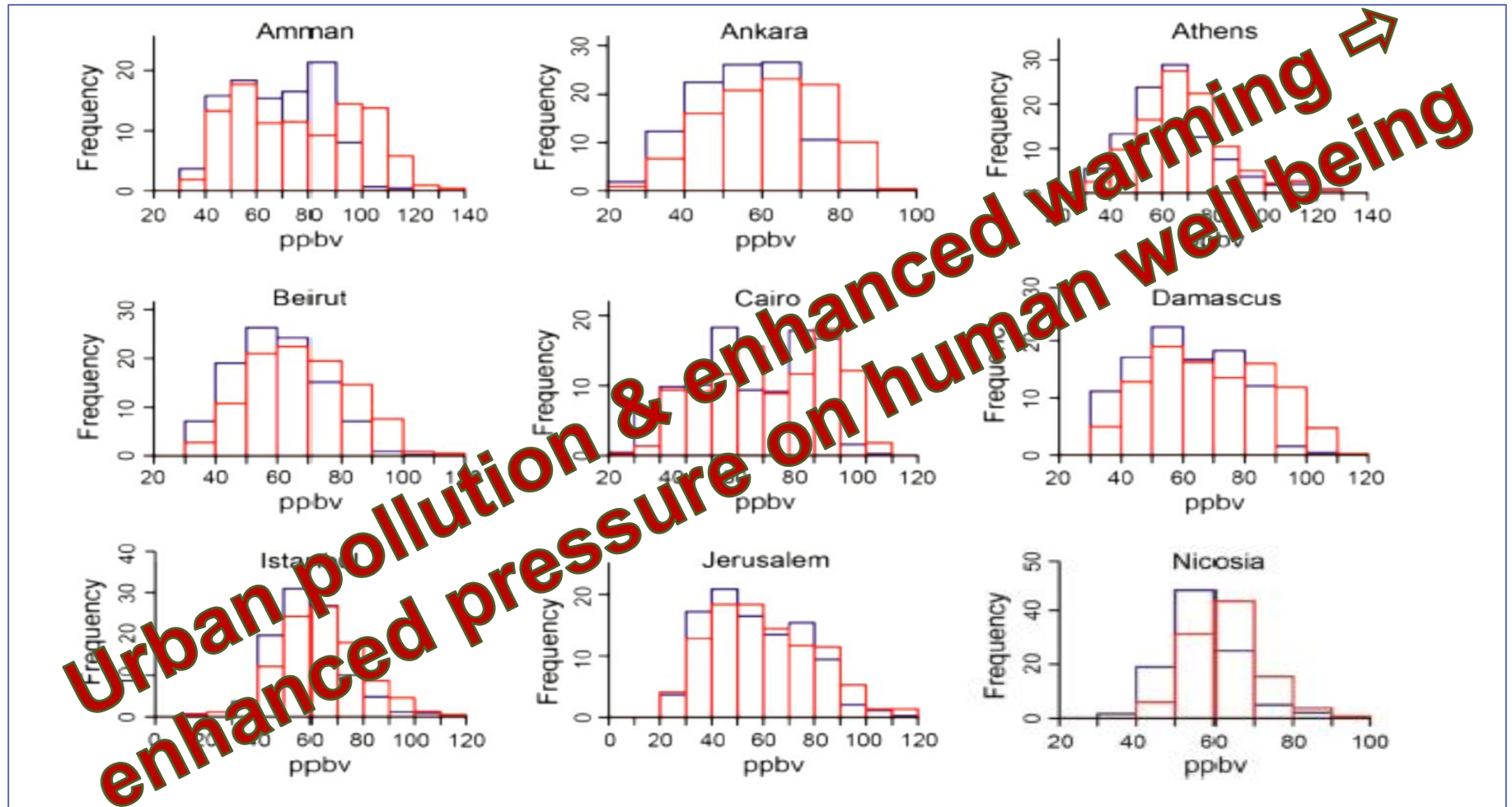
- Aerosol concentrations (i.e., $\text{PM}_{2.5}$) exceed limit in many EMME/MENA cities¹⁾



1) Source: World Bank, Annual $\text{PM}_{2.5}$ exposure

<http://futureearth.org/mena-centre>

EMME Region: Urban Air Quality



Recent and mid-century **ozone** distributions. Model-calculated frequency histograms (%) of ozone mixing ratios at the surface in summer (JJA). The **blue diagrams** indicate the reference calculation for the year **2005**, and the **red ones** refer to the year **2050**; Source: Lelieveld et al., (2014)



What to do about
global changes (in cities)?



THE CYPRUS
INSTITUTE



future^{earth}

research for global sustainability
MENA Regional Center

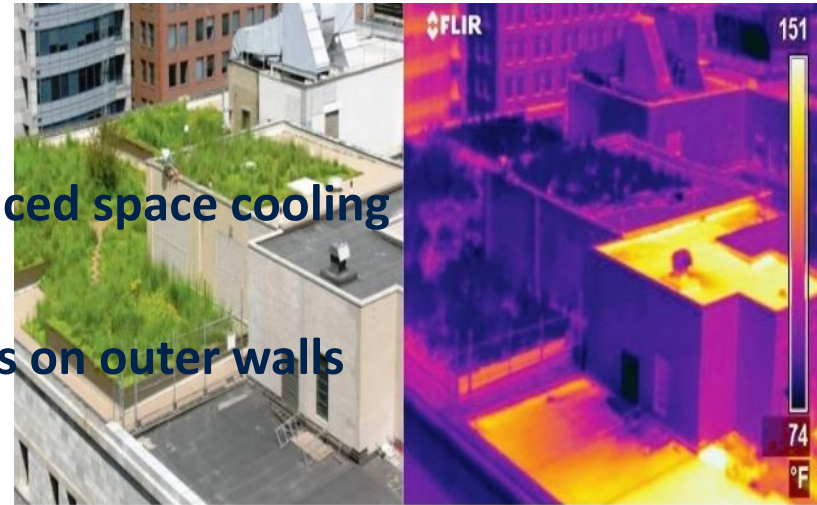
<http://fe-mena.cyi.ac.cy/index.php>

Mitigation/Adaptation to Urban Warming

- There are several mitigation/adaptation options to reduce urban warming and its impacts:

- Building design measures:

- Enhanced insulation of buildings
- Increased energy efficiency and reduced space cooling
- Positioning of building and shading
- Reflective, low heat capacity coatings on outer walls
- Green roofs



- City planning and design

- Reduce individual traffic through (electric/hybrid) public transportation
- Street layout to enhance free airflow and ventilation
- Cool pavements
- Tree plantation and preservation
⇒ more city parks and green areas



Future Earth MENA

- **The Future Earth MENA Regional Center (FEMRC)**
- (FEMRC) as one of the elements of the Central and Eastern Europe Secretariat of Future Earth
(<http://futureearth.org/mena-center>)
- The FEMRC aims to bring together the regional research community to serve the needs of the local to regional communities
- **Global Change Assessment and Policy Recommendations**
 - Evaluate the magnitude of climate- and global environmental changes and their impacts in the EMME/MENA Region
 - Understand the main drivers of global changes in the region
 - Assess the combined risks to water-, energy- and food security in the MENA region and explore sustainable solutions
 - Identify **concrete** “generic” strategies/measures for effective adaptation and to enhance resilience of local communities and urban centers
 - Provide recommendations for policy makers on such strategies



Conclusions

- EMME/MENA: a region of significant diversity, **high population growth rates and enhanced urbanization**
- Climate change **above global means** in EMME Region
- Climate warming and low air quality are **exacerbated in cities and urban structures**
- **Coastal cities/communities** with population of up to 174 Mill. in 2025 **particularly threatened**
- Need for **effective adaptation** through portfolio of suitable measures ⇒ **enhance resilience**
- FEMRC aims to advance **concrete “generic” solutions** for EMME/ MENA cities ⇒ **Regional FE Research Agenda**



Thank you for your kind attention

Contact: Prof. Dr. Manfred A. Lange, The Cyprus Institute
P.O. Box 27456; CY-1645 Nicosia, Cyprus
manfred.lange@futureearth.org or m.a.lange@ www.cyi.ac.cy