Complexity^3 =

climate change X urban territorial planning X coastal cities

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Protecting coastal cities from sea level rise

Aula Magna Tolentini
Iuav University of Venice, Italy
July 21, 2023

Beirut by Yaser Abunnasr

Content

Complexity

- Climate change is not understood sufficiently
- Urban territorial planning is a complex multilayered discipline
- Coastal cities at juncture of terrestrial and marine ecosystems

Multiple variables and parts that are inter-connected and inter-dependent

Complexity [3] in general

Climate Change

- Science of multiple interactions-uncertainty
- Impacts not fully understood
- Solutions require changes to our systems
- Difficult politics
- Long-term problem
- A problem we must address

Planning

- Multiple interconnected elements
- Multiple stakeholders involved
- Uncertain future-decisions may not be effective
- Limited resources means trade-offs
- Cities in constant change - population increase
- Different planning approaches
- Challenging politics

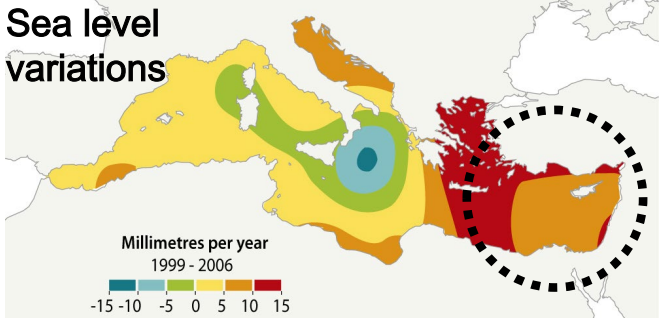
Coastal Cities

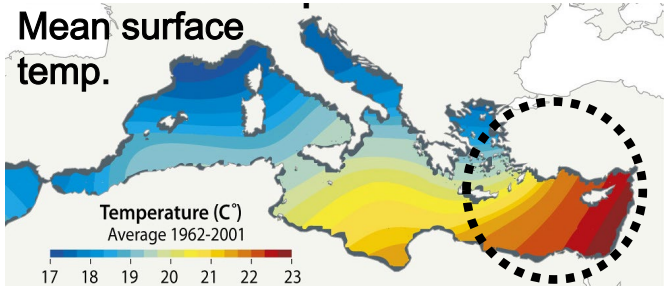
- 44% of global population
- Intersection of land and sea
- Centers of economic activity
- Major infrastructure
- Maritime trade routes
- Multiple challenges
- Historical sites with constant human settlement

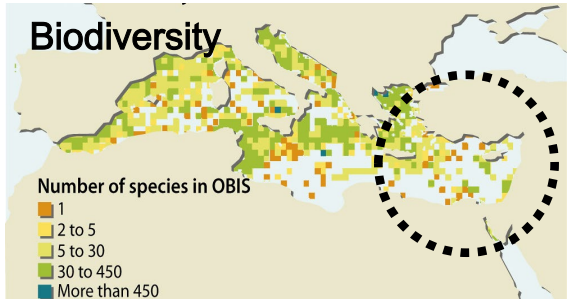
Eastern MED

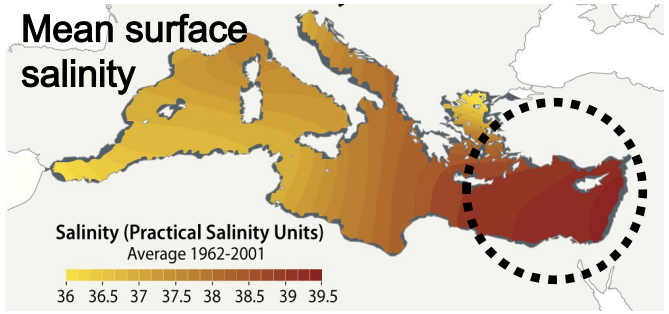
Interacting factors

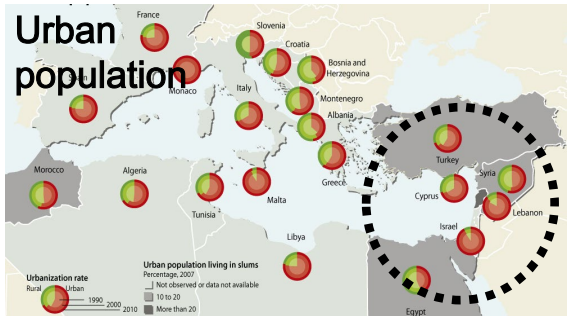
- coastal urban density
- Sea level rise
- Economic activity
- Environmental & ecological degradtaion
- High vulnerability







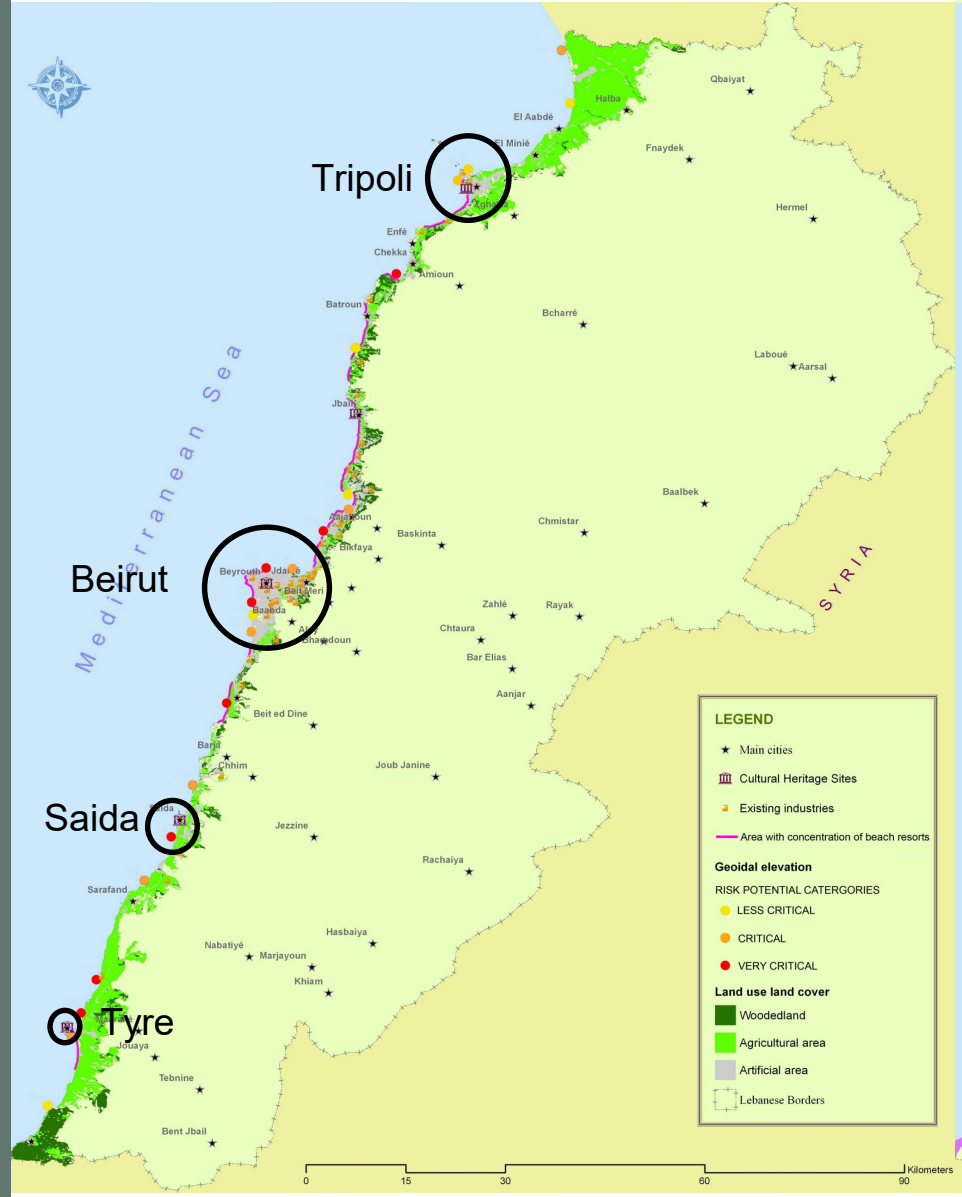




Source: GRID Arendal, UNEP partner (2022)

Lebanon Coast

- 230km long, very narrow
- 4 largest cities
- 3 main sea ports
- Main Airport
- Sand and rocky shore
- Diversity of landuses
- Diversity of habitats
- Varying risk levels



Landuse along the coast of Lebanon

Urban 40% ● Agriculture 41% ● Natural/Cultural heritagee 19%

Shoreline types along the coast of Lebanon

Source: UNDP and MoE (2015)

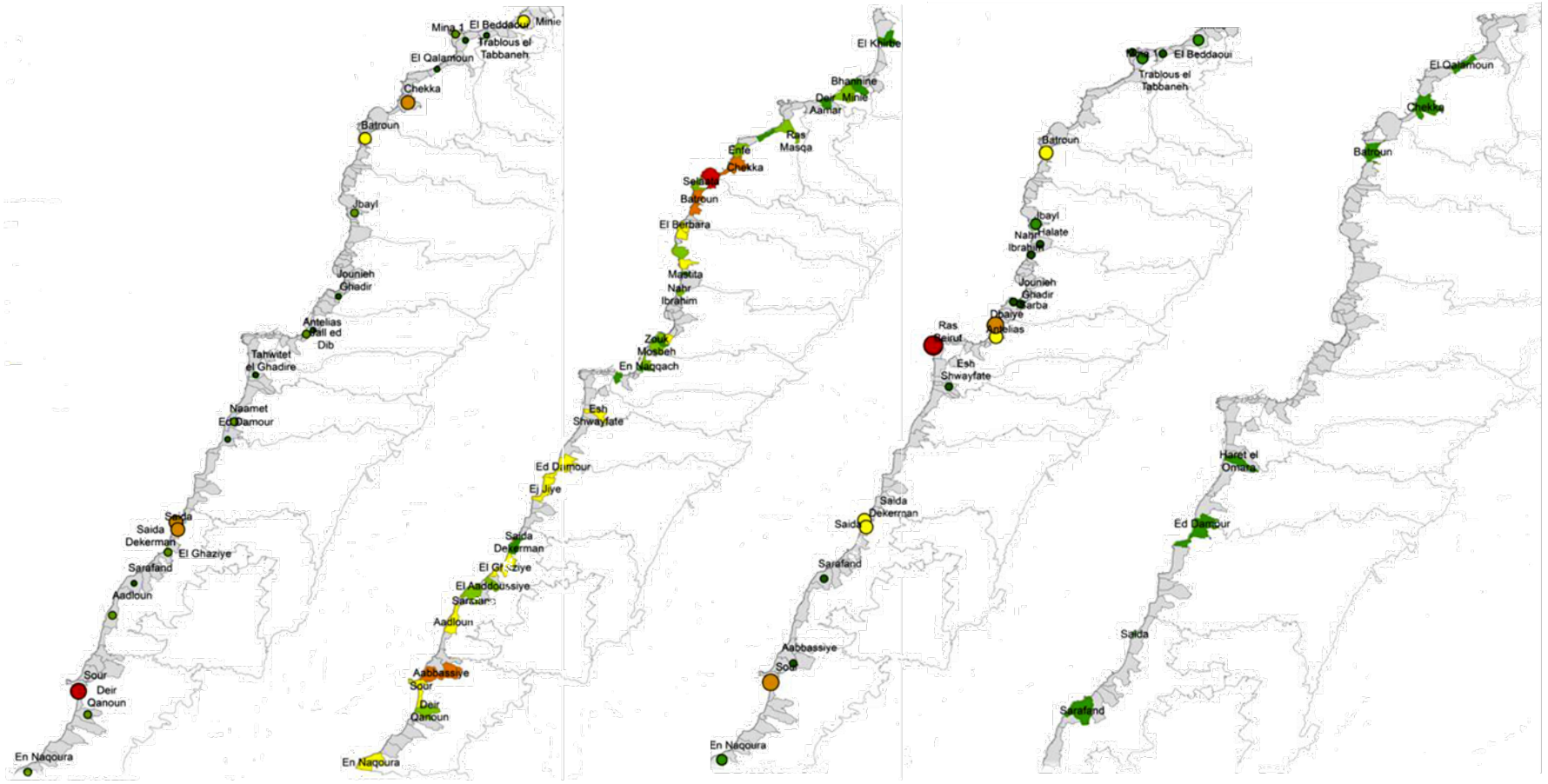
Lebanon Coast

Multiple Climate changes stresses/risks

- Combination of fires, flooding, land slides, heavy rain, pollution & erathquak fault

Multiple climate change imapcts

- Rising sea level
- Storm surges
- Excessive heat
- Reduced precipitation



Source: IFI, Climate Change and Enviroemnt Unit, AUB (2022)

Complexity [3] Lebanon coastal cities

Climate Change

Sea level rise

- 5-10mm/yr. since 1993
- 45-50cm by 2050
- Salt water intrusion
- Coastal flooding
- Coastal erosion
- Impact on activities
- Erosion/inundation-cultural & natural sites

Heating: +1.7° C (RCP 8.5)

Rain:-11%(RCP 8.5)

Planning

- Top-down approach
- Based on real estate valuation of land & driven by developers
- Lack of clear jurisdictions across planning units
- Outdated planning tools
- Absence of environmental considerations in zoning and building codes
- Climate change does not factor
- Lack of capacities in municipalities, planning unit

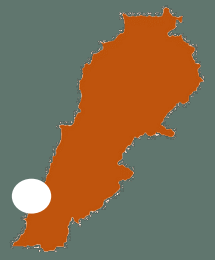
Coastal Cities

- 55% of population
- 35% of built area
- 74% of GDP
- Extreme illegalities
- Excessive pollution
- Deteriorating marine ecosystems
- Heavily built, few green spaces
- Privatized coastline
- Limited accessibility

Vulnerbaility Assessment

- Being carried across primary coastal cities
- Assessment of critical sectors
- Develop local capacities

City of Tyre



A SECTOR APPROACH TO CLIMATE CHANGE VULNERABILITY OF COASTAL CITIES IN LEBANON

THE CASE OF TYRE

VULNERABILITY = **EXPOSURE** + **SENSITIVITY** − **ADAPTIVE CAPACITY**

Is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.

Refers to the character, magnitude, and rate of change and variation in the climate.

Determines the degree to which a system is adversely or beneficially affected by a given climate change exposure.

Refers to 'the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences'.

COLOR-CODING USED IN THE IMPACT CHAINS

Potential Impacts of the Vulnerability | Vulnerability of the Sectors | Exposure Components | Sensitivity Components | Adaptive Capacity Components

VULNERABILITY SCORE

Value within range 0 to 1

Favorable 0 – 0.2 | Fair > 0.2 – 0.4 | Neutral > 0.4 – 0.6 | Poor > 0.6 – 0.8 | Very Poor > 0.8 – 1

TOURISM

- Temperature (0.45) + Extreme Precipitation (0.45) + Land Use Land Cover (0.34) + Air Quality Sea Water Quality (0.34) − Funding Governance (0.90) = Vulnerability of Touristic Destination (0.65)
- Temperature (0.45) + Extreme Precipitation (0.45) + Structures' Proximity to Shore (0.87) + Structures' Elevation & Protection (0.87) − Funding (0.77) + Governance (0.77) + Maintenance (0.77) = Vulnerability of Operations of Touristics Destinations (0.71)

→ VULNERABILITY OF TOURISTIC ATTRACTIONS: 0.68

WATER RESOURSES

- Temperature (0.65) + Extreme Precipitation (0.65) + Land Use Land Cover (0.26) + Water Quality (0.26) − Efficiency Measures (0.80) + Diversifications of Water Resources (0.80) + Water Governance (0.80) + Funding (0.80) + Storage (0.80) = Vulnerability of Water Flow and Supply (0.63)
- Temperature (0.50) + Extreme Precipitation (0.50) + Structures' Proximity to Shore (0.75) + Structures' Elevation & Protection (0.75) − Efficiency Measures (0.55) + Funding (0.55) + Diversification of Water Resources (0.55) + Urban Planning (0.55) = Vulnerability of Water Demand (0.59)

→ VULNERABILITY TO CHANGE IN WATER AVAILABILITY: 0.61

FISHERIES

- Temperature (0.61) + Precipitation (0.61) + Marine Biodiversity (0.60) + Fishing Techniques (0.60) + Sea water Quality (0.60) + Coastal Zone (0.60) − Fishermen's Socio-Economic Conditions (0.55) + Coastal Zone Managment (0.55) + Capacity Building (0.55) + Governance (0.55) = Vulnerability to Change in Fish Catch (0.58)
- Storms (0.15) + Fishing Ports (0.49) + Fishing Vessels (0.49) − Coastal Zone Management (0.58) + Emergency Plan (0.58) + Maintenance (0.58) + Governance (0.58) = Vulnerability of Fishing Infrastructure (0.45)

→ VULNERABILITY OF FISHERMEN'S LIVELIHOOD: 0.51

INFRASTRUCTURE

- Temperature (0.53) + Precipitation (0.53) + Storms (0.53) + Telecommunication Network (0.43) + Stormwater/ Wastewater Network (0.43) + Electricity Network (0.43) + Water Supply Network (0.43) + Transportation Network (0.43) − Funding (0.61) + Governance (0.61) + Energy Mix (0.61) + Maintenance (0.61) = Performance of Infrastructure Network (0.55)

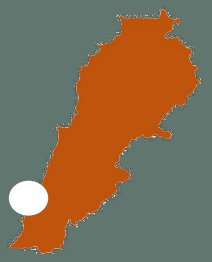
→ VULNERABILITY OF INFRASTRUCTURE NETWORK: 0.55

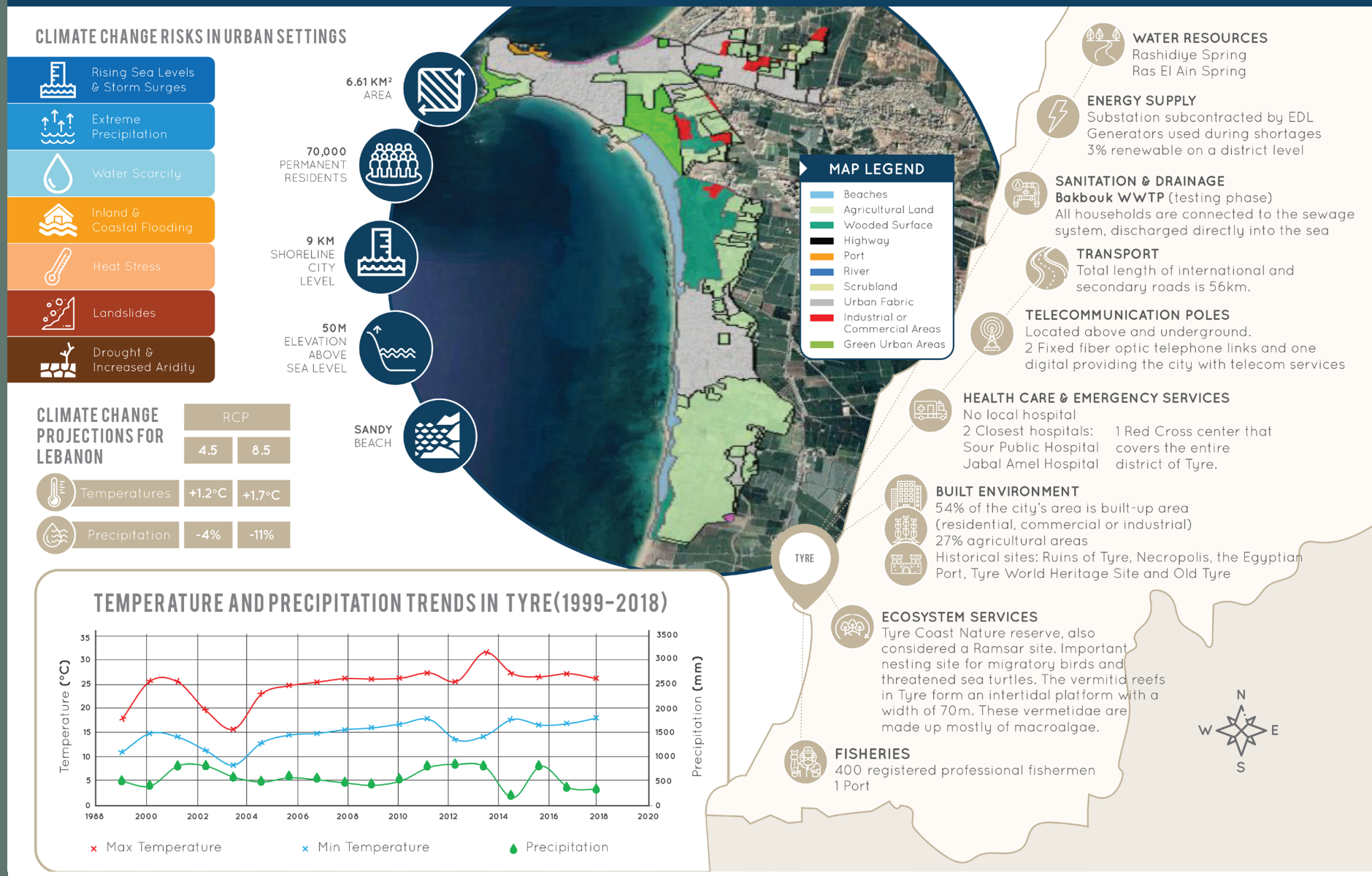
Source: IFI, Climate Change and Enviroemnt Unit, AUB (2022)

Risk Assessment

- Risk assessment of each coastal city
- Across sectors, land use and environmental stresses
- Based on predicted climate change scenarios

City of Tyre





Source: IFI, Climate Change and Enviroemnt Unit, AUB (2022)

Beirut Urban Coastal planning

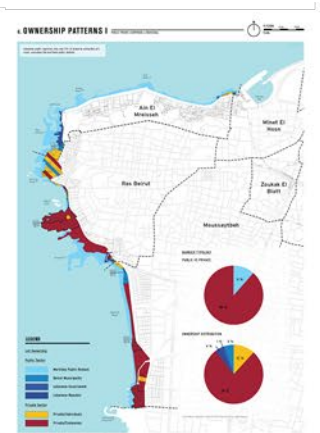
- Multi-Layered Analysis
- Simeltaeaously address physcial, social, economic, and policy


Changing Coast

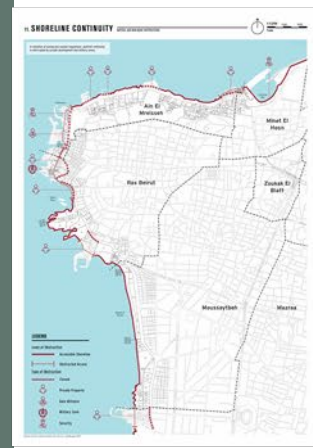

Cultural & Social


Socio-economic


Biodiversity


Owenrship


Visual Obstruction

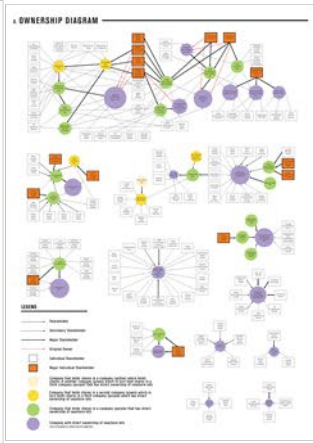

Coast Continuity


Accessibility


Constructability


Zoning

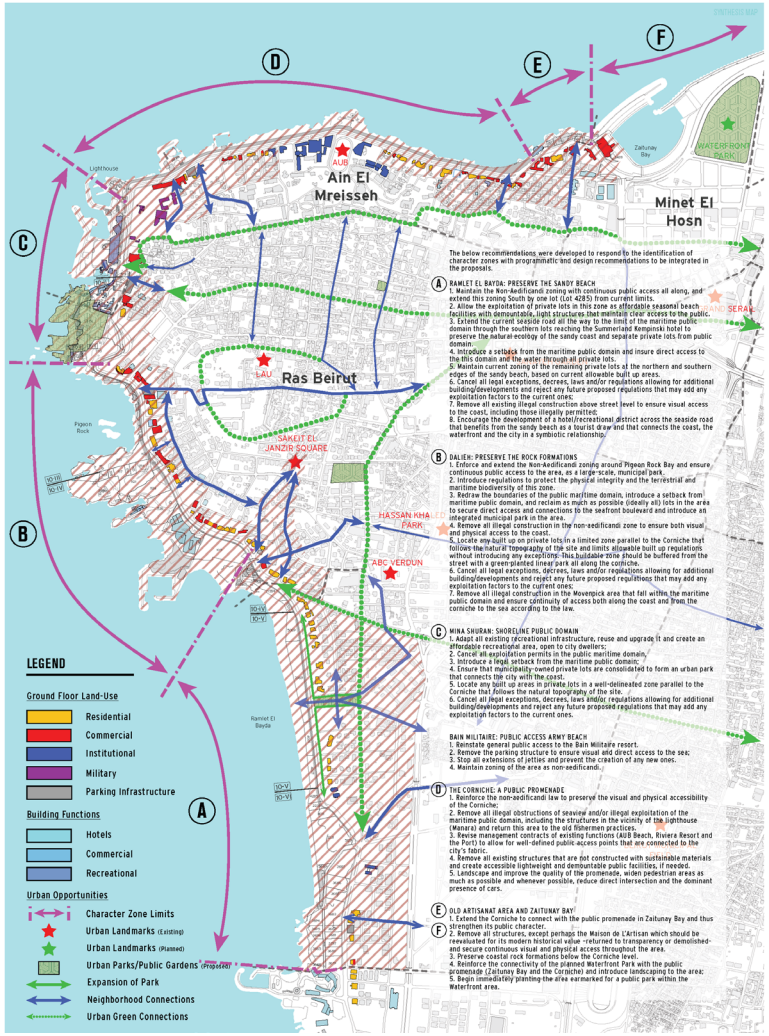

Illegalities


Stakeholders

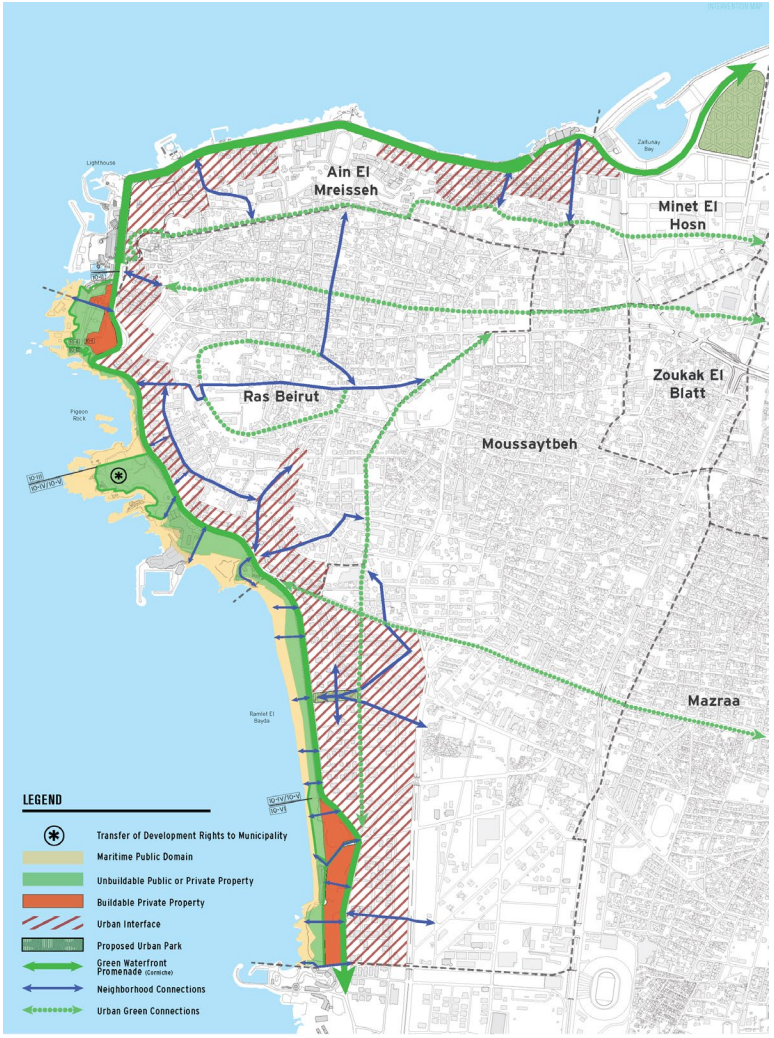
Source: Beirut Urban Lab, AUB (2020)

Urban Coastal Planning

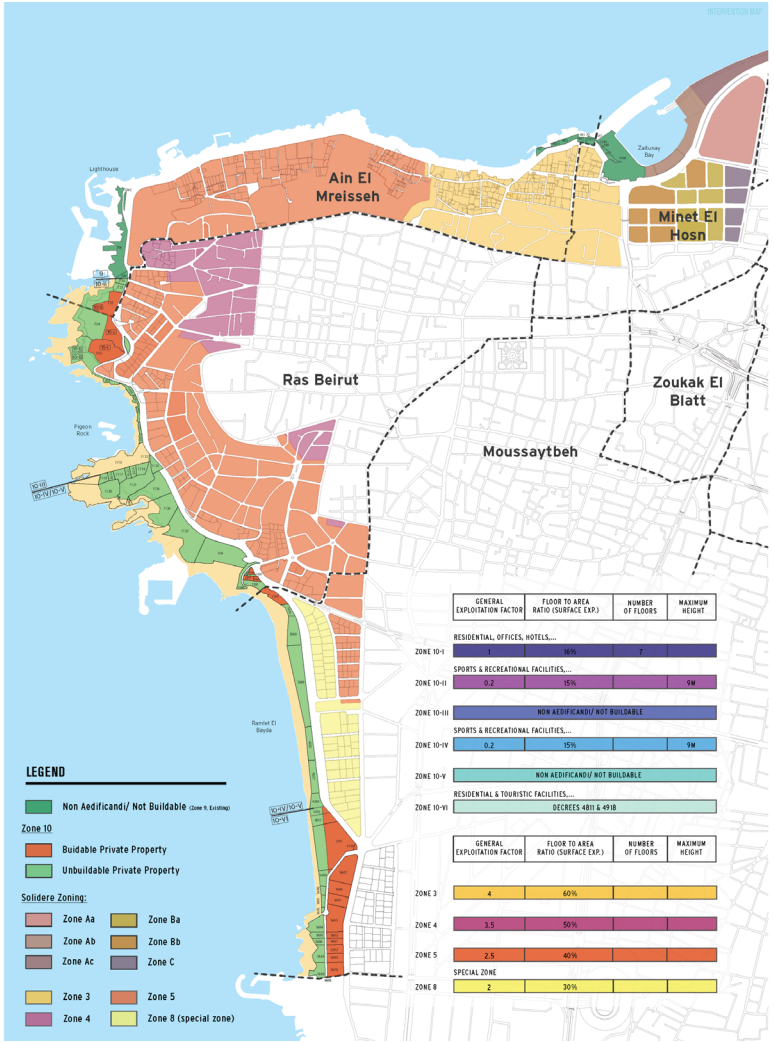
Synthesis -Charcater Zones



Vision



Zoning Proposal



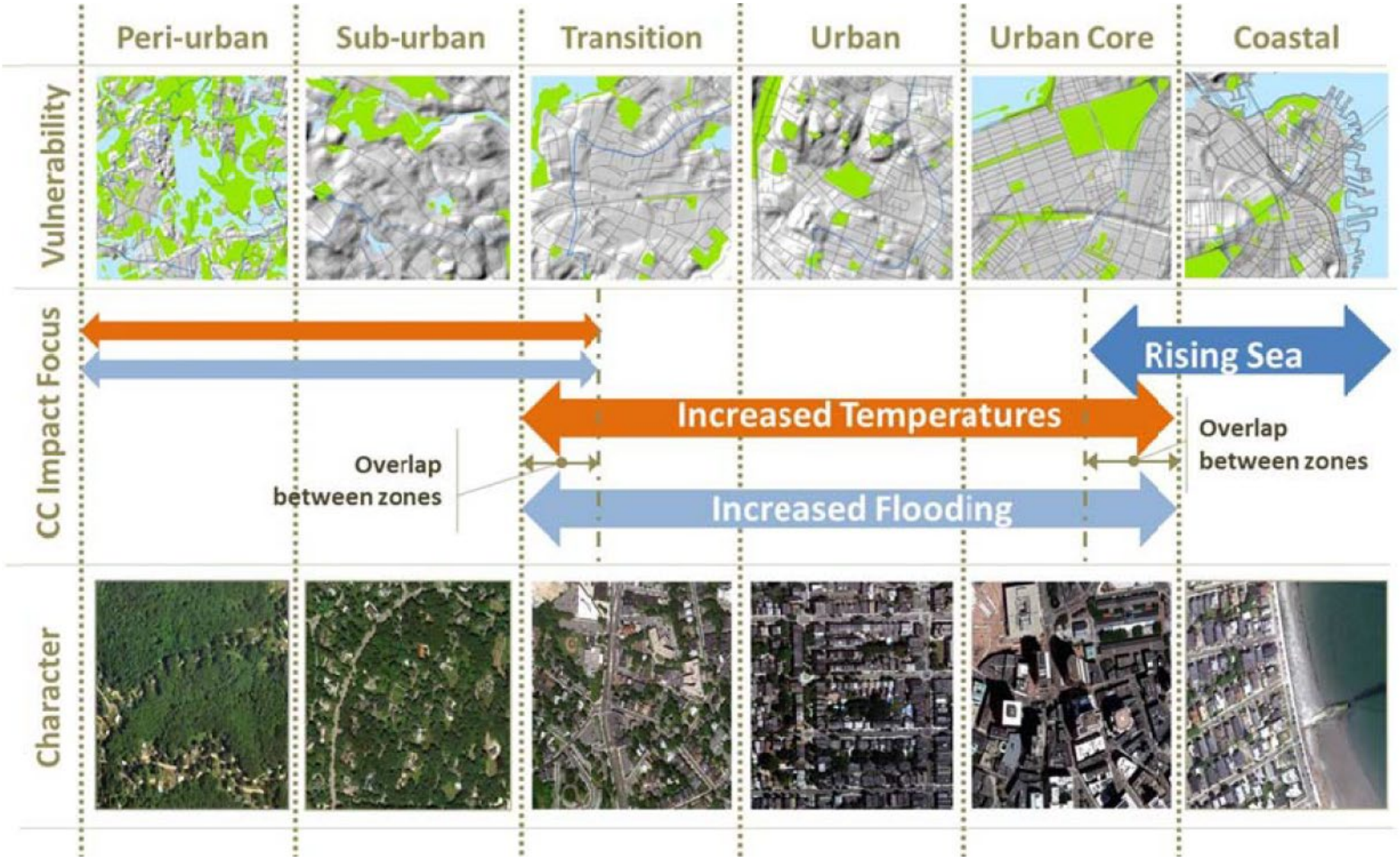
Source: Beirut Urban Lab, AUB (2020)

Complexity 3 Lessons

- **Separate and disconnected Disciplines:** Climate change(SLR in specific) and coastal urban planning are not seen interrelated
- **Disaggregated and partial data**
- **Incomplete picture:** Partial understanding of impacts, synergies, and interactions
- **Applied research cannot be isolated:** repeating the same mistakes and approaches will lead to missing the window of opportunity.

Mainstreaming

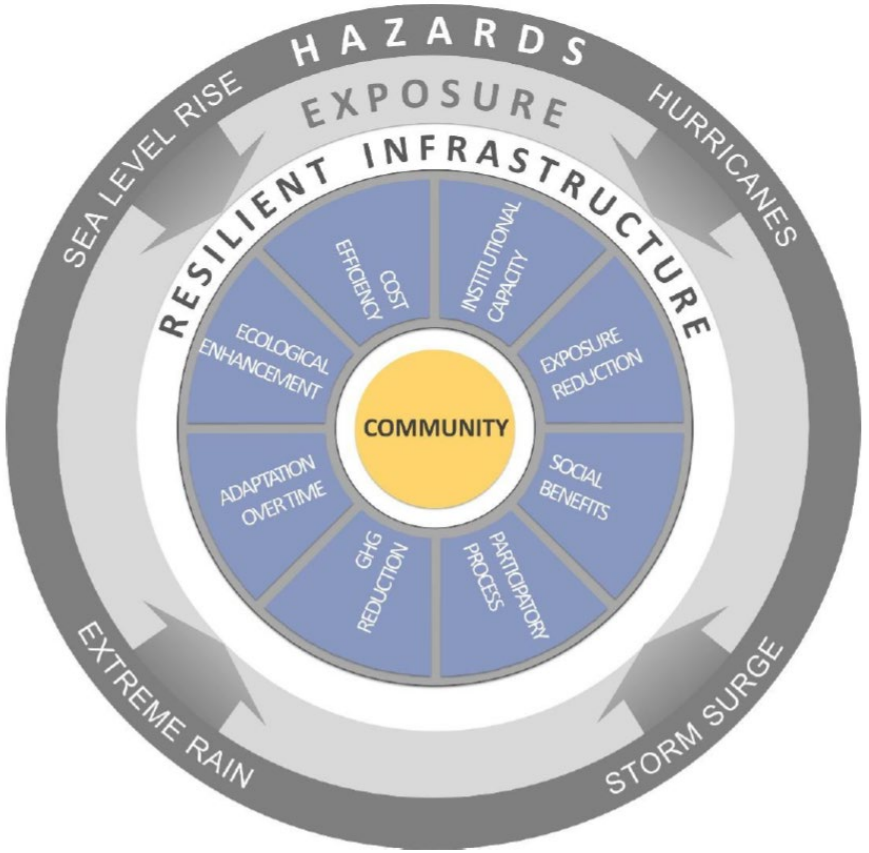
- Mianstream C.C. Into planning
- Synergies and alignements
- Differing morphologies, communities, and policies
- Differing C.C. Imapcts and inetractions

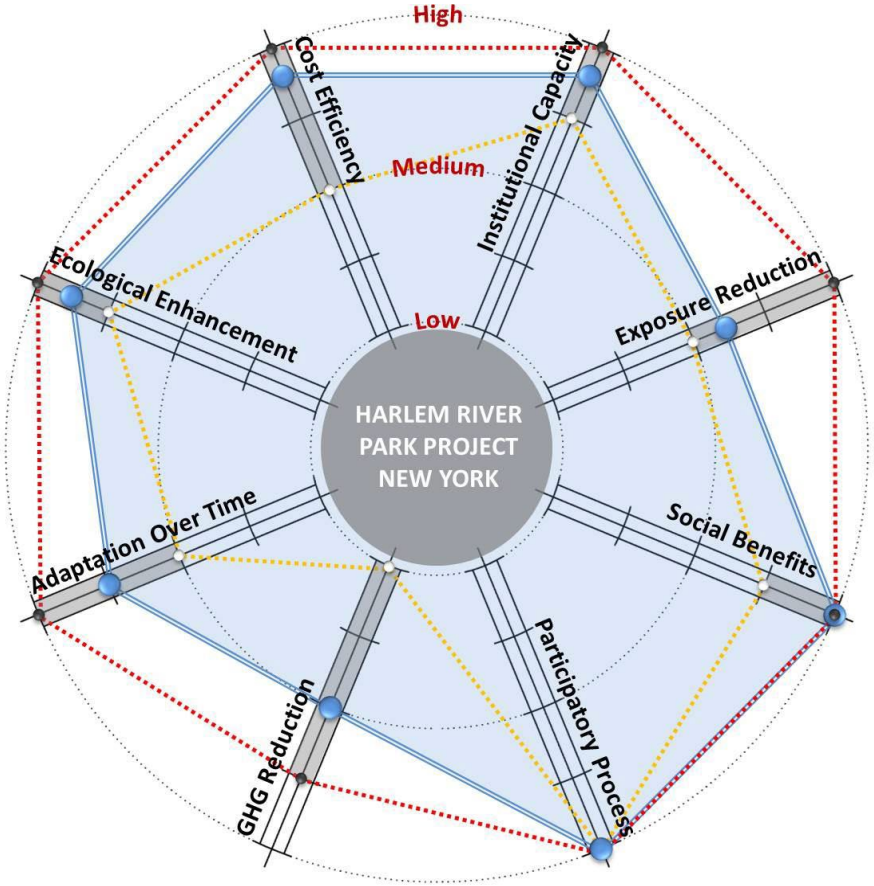


Source: Abunnasr, Y.* and E.M. Hamin (2012). “The Green Infrastructure Transect: An Organizational Framework For Mainstreaming Adaptation Planning Policies”)

Holistic Approach

- Adpataive Coastal Gradients
- To respond to comlexities of inetractions
- Adpatation and mitigation
- Project scale assessment

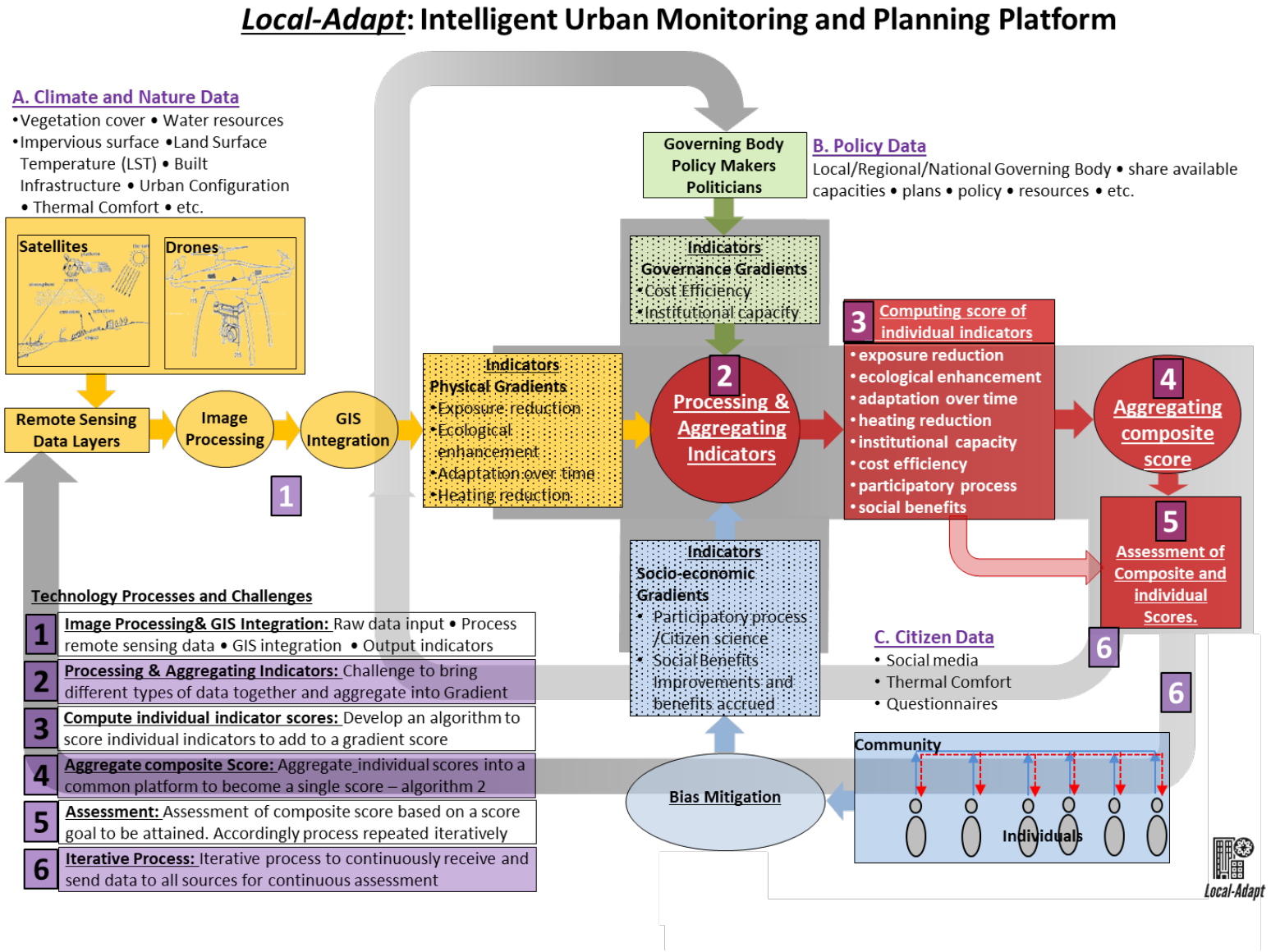




Source: Hamin, EM, Abunnasr, Y.*, Dilthey, M., Albright, E., Buxton, J., DeGroot,D., Judge, T. P., Kenney,M. Kirshen,P., McAdoo, B., Nurse, L. , Roper,E., Ryan,R.L., Sheahan, T. and Fricke, R. (2018) "Pathways to coastal resiliency: the Adaptive Gradients Framework", Sustainability, 10(8), 2629;

Intergated Data

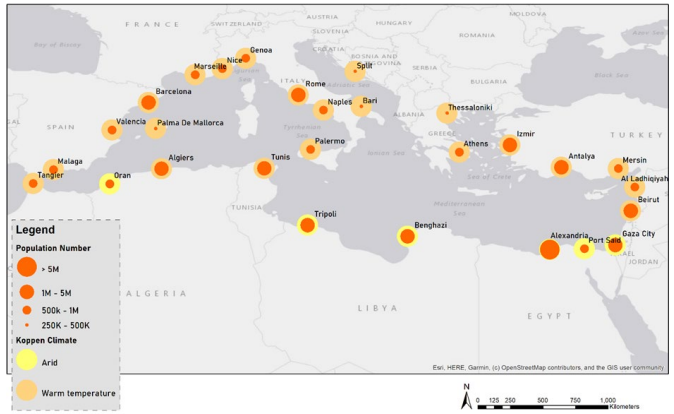
- Use of Ai and smart technology
- Intergate spatial, policy, and citizen data
- Develop a dynamic system of monitoring and planning
- Use by cities, managers, and planners

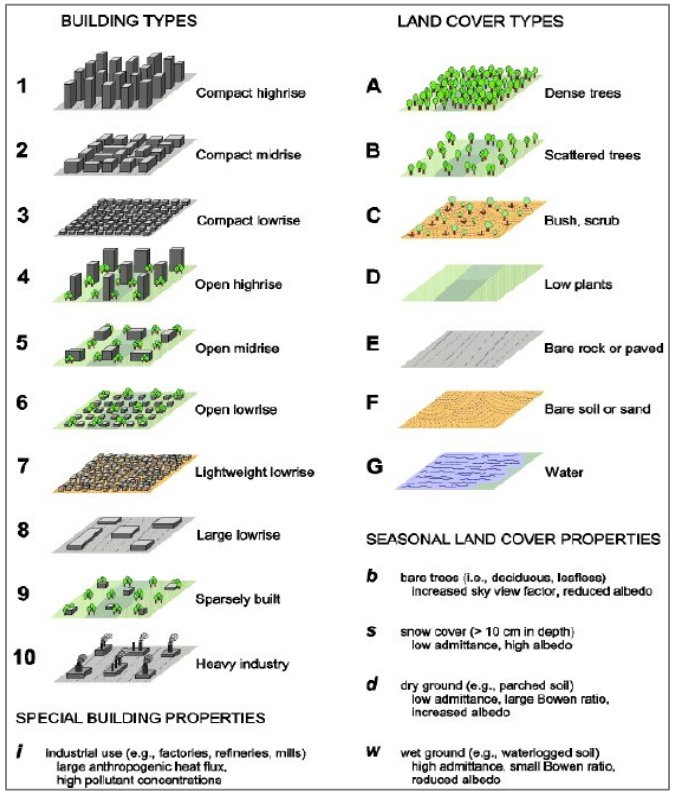


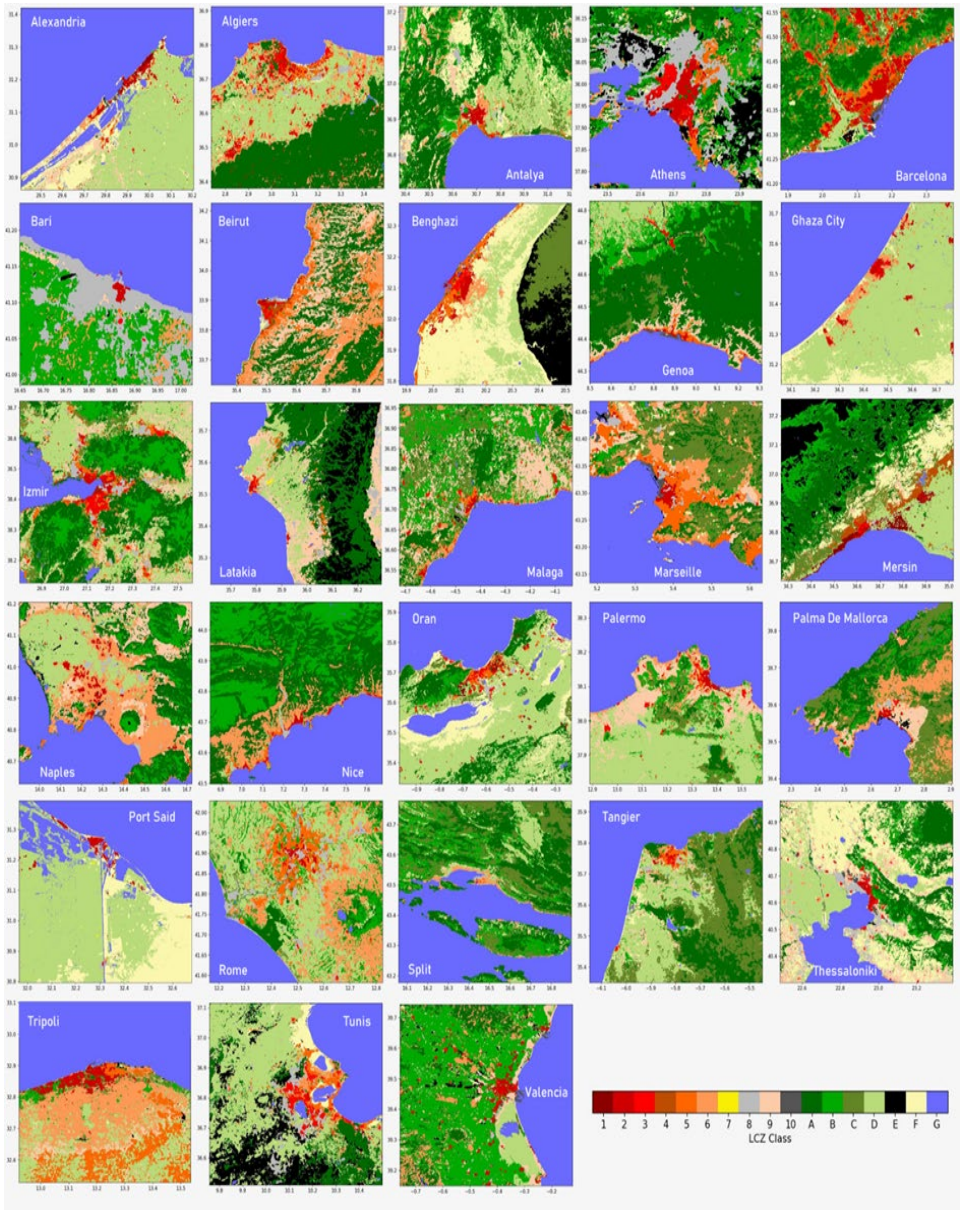
Source: Local Adpat, Intelligent urban monitoring and planning platform; proposal submitted to google.org, 2023)

Regional Network of Research

- 30 Coastal MED cities
- Outdoor human comfort
- Factors imapcting outdoor human comfort – urban morphology
- Arid and warm temperature cities



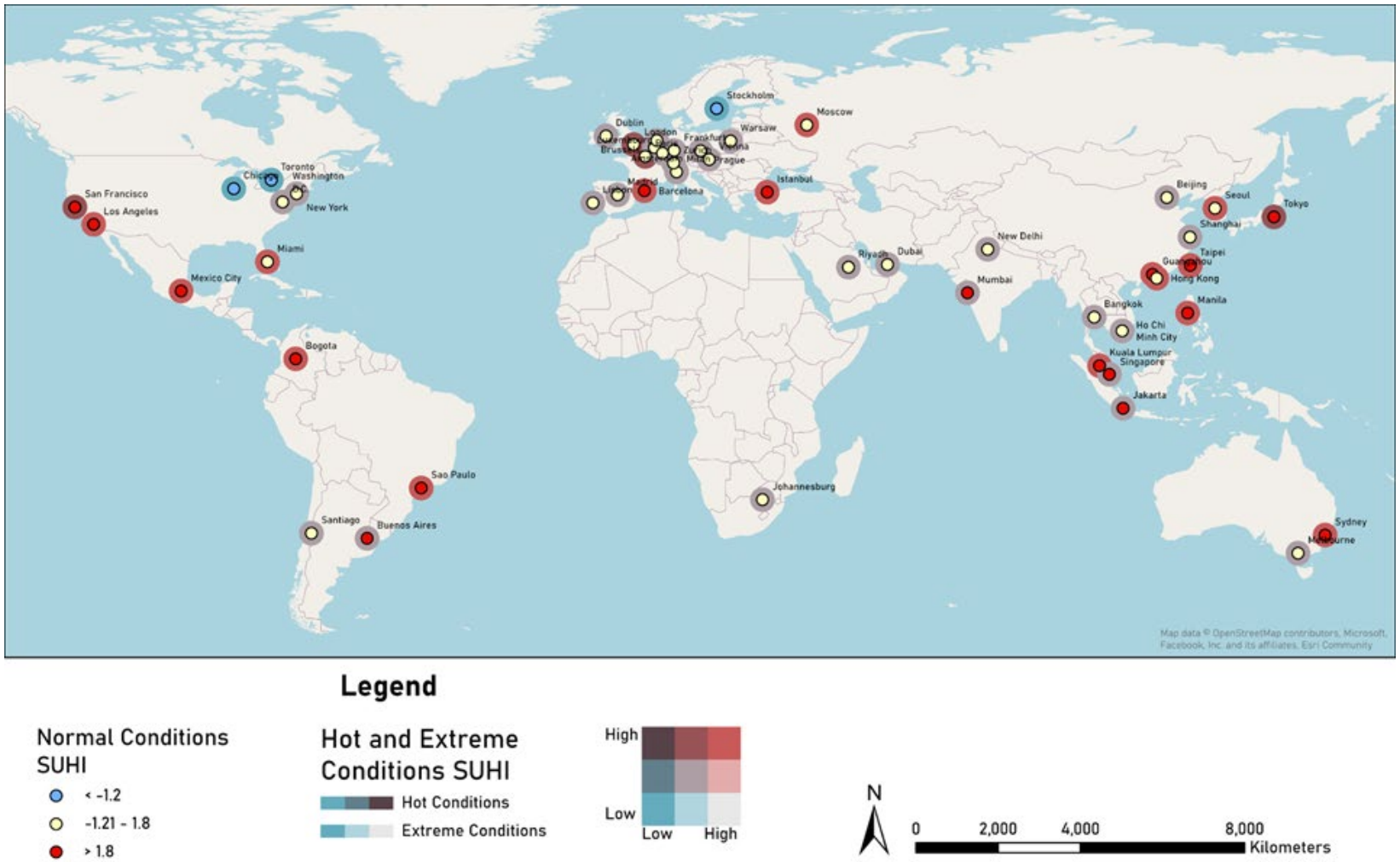




Source: Addressing Outdoor Thermal Comfort in 28 Mediterranean Cities through Cloud Processing and Machine Learning
Yaser Abunnasr, Mario Mhawej,, Sarine Hagopian1 and Aya Al Zein (in preperation)

Global Network of Research

- 50 global cities
- Surface urban heat Island comparative Study
- Factors imapcting and contributing to urban heating
- Application of remote sensing and GIS



Source: Abunnasr, Mhawej, and Al Bitar. Water Features as the Main SUHI Hindering Factor across 50 Global Cities (Urban Climate, in review)

Coastal Resilience

Mainstreaming

- Climate change integrated into urban and territorial planning
- retrofit old and design new resilient coastal cities

Integrated and comprehensive Data

- Develop a comprehensive, robust and integrated approach to data generation
- Support coastal resilience decision making

Holistic Approach

- Considering terrestrial and marine ecosystems, economies, societies as well as natural/cultural systems
- understand externalities of coastal resilience

Network of Applied City Research

- Adopt a regional and global approach to coastal adaptation (i.e. local) to speed up knowledge transfer & lessons learned
- speed up coastal resilience

Thank you

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