Understanding the Urban Environment

NATO S&T Organization: SAS-149
Basics of complex modern urban functions and characteristics

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Agenda

- What is a city?

- Conceptualizing urban terrain

- Cities as systems

- Application and implications

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1.
What is a city?

3

What is a city?

"The criteria for classifying an area as urban may be based on one or a combination of characteristics, such as: a minimum population threshold; population density; proportion employed in non-agricultural sectors; the presence of infrastructure such as paved roads, electricity, piped water or sewers; and the presence of education or health services."

United Nations, Department of Economic and Social Affairs, Population Division (2014), *World Urbanization Prospects: The 2014 Revision, Highlights,* New York: United Nations, pp. 1-7

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Demographic vs Geographic-Functional definitions

Demographic: a city is a human settlement with four characteristics: *permanence*, large *population size*, high *population density* and *social heterogeneity*.

Wirth, Louis (1938) "Urbanism as a Way of Life" in *American Journal of Sociology,* Vol. 44, pp.1-24.

Geographic-functional: a city is a settlement that performs *urban functions* beyond its own boundaries—as an economic centre serving a wider hinterland, as the seat of government for a larger political entity, or through a religious/cultural role. A city exercises urban functions with regional, national or global impact.

Fox, Richard G, (1977), *Urban Anthropology: Cities in their Cultural Settings*, Englewood Cliffs: Prentice-Hall
Smith, Michael E. (1989), "Cities, Towns, and Urbanism: Comment on Sanders and Webster" in *American Anthropologist*, Vol. 91, pp. 454-461
Smith, Michael E. (2008), *Aztec City-State Capitals*, University Press of Florida, Gainesville.

city

An urban agglomeration is a concentration of population in a given urbanized area (similar to the geographical "metropolitan area" as distinct from "city limits"). For example:

- Washington DC metro area (pop 5.95m) covers portions of Northern Virginia and Maryland in a contiguous urbanized zone encapsulating the much smaller District of Columbia—the "city" of Washington—of only 659,000 in 2014. This area, though comprising several political units known as "cities", is a single urban agglomeration.

- Metro Manila is a polycentric agglomeration incorporating the City of Manila plus 15 satellite cities. Metro Manila had a population of 11.8 million in 2010, within a Greater Manila Metro Area of 25.5 million, which in turn nested in a city cluster ("Mega Manila") of 35.6 million. The City of Manila (just one government unit in this massive agglomeration) had a population of only 1.65 million.

Thus, cities are urban units nesting within larger urban agglomerations, which themselves nest in conurbations of several linked cities, or megalopolises—city clusters linking many conurbations.

Urban system-in-focus

City-cluster
e.g. Megalopolis, Urban Corridor

Conurbation

Urban
Agglomeration
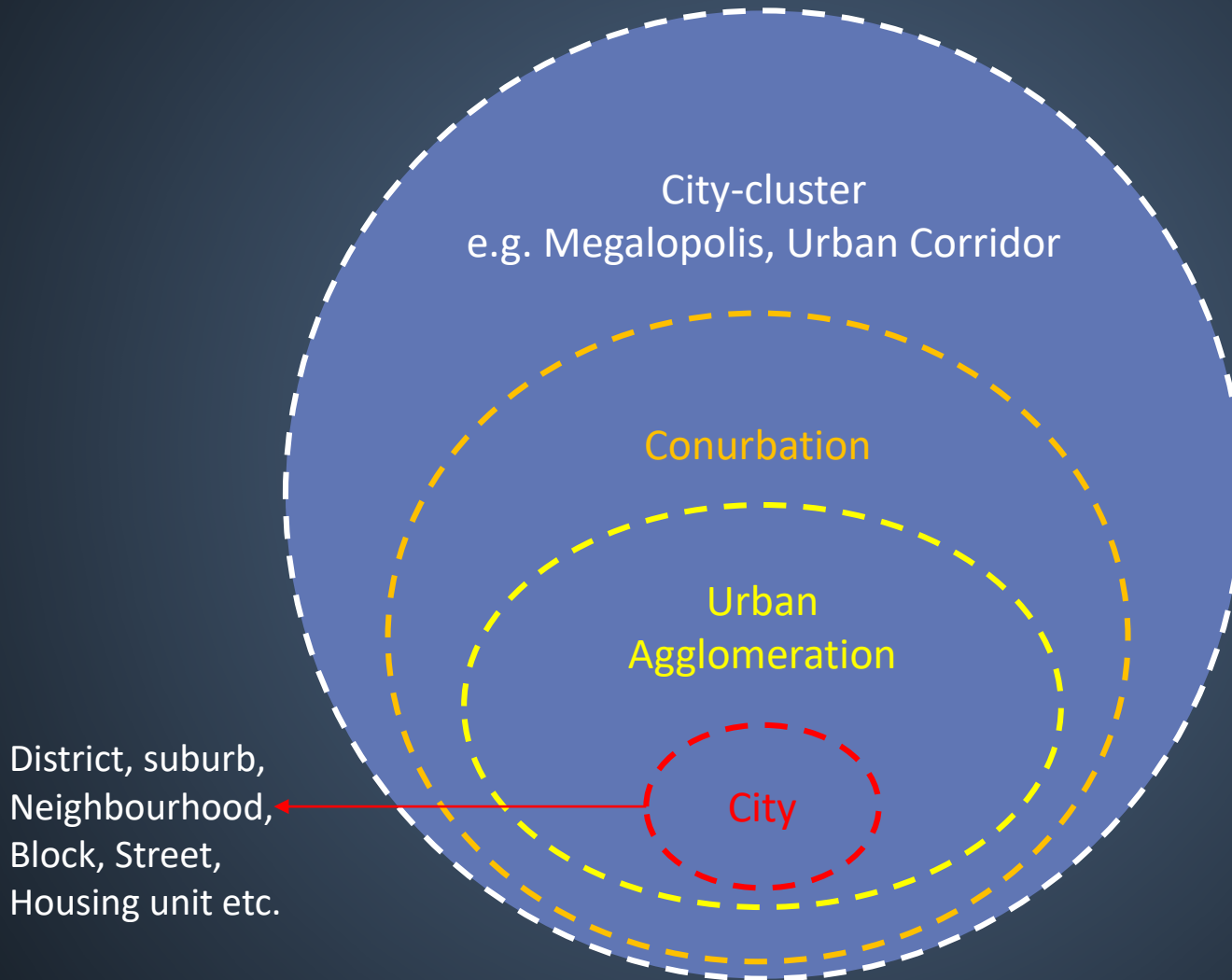
District, suburb,
Neighbourhood,
Block, Street,
Housing unit etc. ← City

7

environments

"When conceptualizing urban operations, commanders must understand two important terms: urban area and urban environment. The first is a subset of the second. An urban area is a topographical complex where man-made construction or high population density is the dominant feature. Focusing on urban areas means concentrating on the physical aspects of the area and their effects on weapons, equipment, line-of-sight, and tactics, techniques, and procedures. The urban environment includes the physical aspects of the urban area as well as the complex and dynamic interaction and relationships between its key components—the terrain (natural and man-made), the society, and the supporting infrastructure—as an overlapping and interdependent system of systems."

United States Army (2006), FM 3-06 *Urban Operations*, p. 1-2

The Urban Triad (JP 3-06, 2013)

(a) **A complex man-made physical terrain** is superimposed on existing natural terrain. This physical terrain consists of man-made structures of varying types, sizes, materials, and construction arranged sometimes in an orderly manner and sometimes randomly. It may be modern or built around an ancient core; it may contain towering buildings or none over three stories.

(b) **A population of significant size and density** inhabits, works in, and uses the man-made and natural terrain. Urban areas are frequently defined according to size, from villages of fewer than 3,000 inhabitants to large cities with populations of over 100,000. Large cities vary enormously in size, ranging in population from 100,000 to over 20,000,000 and in area from several to hundreds of square miles. Sociocultural characteristics are the essential focus of population analysis.

(c) **An infrastructure upon which the area depends** also occupies man-made terrain and provides human services and cultural and political structure for the urban area and often beyond, perhaps for the entire nation. An urban area may have a significant influence beyond a city's boundaries. It may influence a region within the nation, the nation itself, or other countries within a geographical region.

This urban triad view establishes a foundational perspective that reveals an interaction between the physical terrain, the population, and the infrastructure of an urban area. This view also reveals the urban area as a complex and **dynamic system**, with unique political, military, economic, social, information, and infrastructure (PMESII) and other components.

JP 3-06, Joint Urban Operations, November 2013

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Urban triad vs urban quad

A city is an "urban triad consisting of *complex man-made physical terrain*, a *population of significant size and density and varying sociocultural groupings*, and an *infrastructure*."

United States Department of Defense (2013), JP 3-06 *Joint Urban Operations*, p. vii

NATO's Urbanization Capstone Concept adds complex informational terrain to the triad, to conceptualize an urban quad comprising population, terrain, infrastructure and information.

2.
Conceptualizing urban terrain

Complex Terrain—DSTO, 2005

Analysis of the RTA trial data led to the simplified definitions of terrain and vegetation used in this study (Bowley and Brewer 2001). The definitions relate the impact of terrain and vegetation on the range of direct fire weapons and the detection range of sensors. Accordingly the following definitions were adopted for this study.

- **Open terrain** is defined as being terrain where likely *detection ranges are greater than effective weapon ranges*, e.g. flat desert areas.

- **Restricted terrain** is where likely *detection ranges are shorter than effective weapon ranges*, e.g. jungle or mountainous areas.

- **Complex terrain** is effectively a "patchwork" of these basic terrain types.

Bowley, Castles and Ryan (2004), 3

systems

- Cities are a subset of *complex terrain*: a patchwork of open and restricted areas, where *open terrain* consists of areas where sight lines are longer than weapon ranges, and *restricted terrain* consists of areas where sight lines are shorter than weapon ranges.

- Electronic connectivity, far greater in urban than in rural areas, enables urban agglomerations to develop a dense, complex *informational terrain* alongside their *physical* and *human terrain*

- Urban centres are subsystems within broader complex adaptive systems that behave like biological systems.

- They nest in a networked pattern of flows, interactions and interdependencies across a rural, peri-urban and urban continuum.

- Urbanization is a process where population, land use, and economic activity in a given area become increasingly urban—based within, or dependent on, urban agglomerations.

Bowley, Dean K, Taryn D. Castles and Alex Ryan (2004), *Attrition and Suppression: Defining the Nature of Close Combat*, Defence Science and Technology Organisation, Salisbury, South Australia, p. 3

Kilcullen, David J. (2013), *Out of the Mountains: The Coming Age of the Urban Guerrilla,* New York: Oxford University Press, Chapter 1 and Appendix A.

Feral Cities—Norton, 2003

Imagine a great metropolis covering hundreds of square miles. Once a vital component in a national economy, this sprawling urban environment is now a vast collection of blighted buildings, an immense petri dish of both ancient and new diseases, a territory where the rule of law has long been replaced by near anarchy in which the only security available is that which is attained through brute power.

Such cities have been routinely imagined in apocalyptic movies and in certain science-fiction genres, where they are often portrayed as gigantic versions of T. S. Eliot's Rat's Alley.

Yet this city would still be globally connected. It would possess at least a modicum of commercial linkages, and some of its inhabitants would have access to the world's most modern communication and computing technologies. It would, in effect, be a feral city.

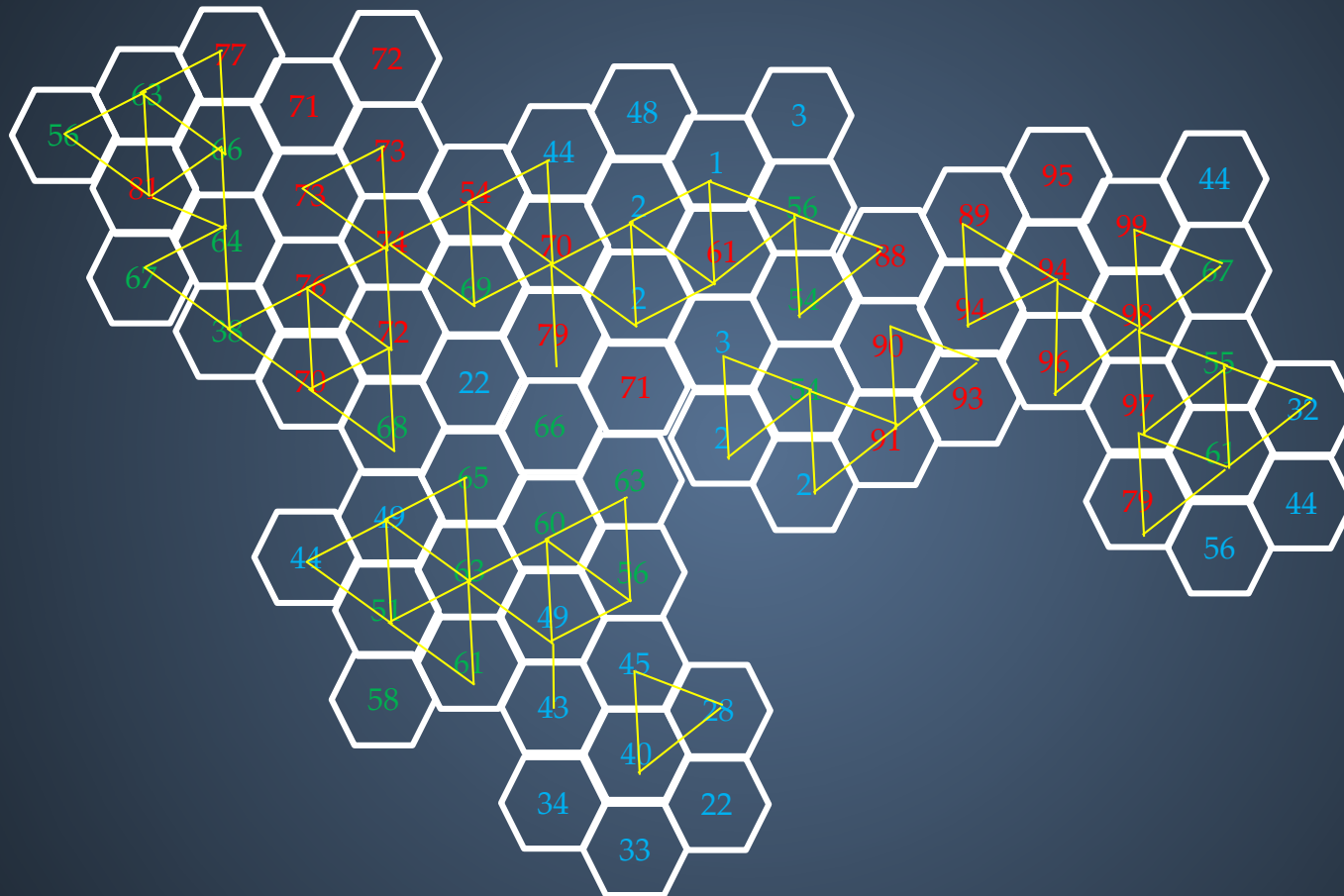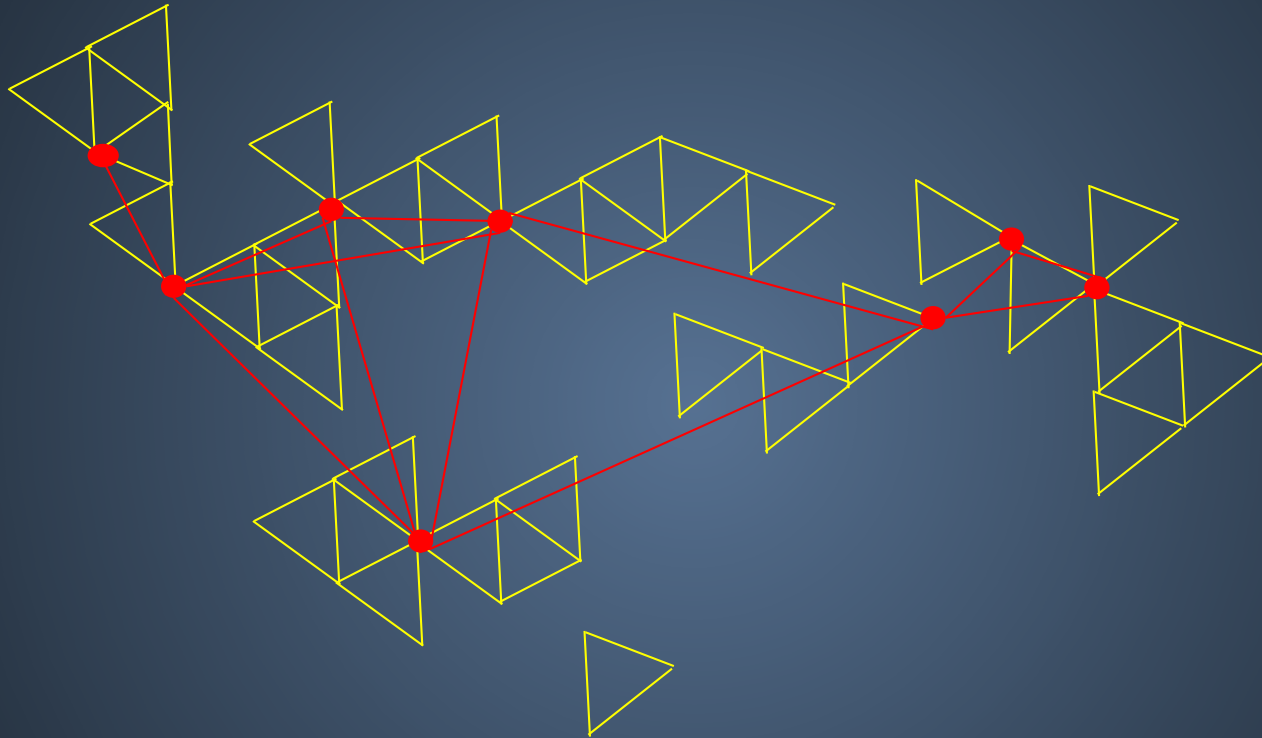Richard Norton (2003), 97

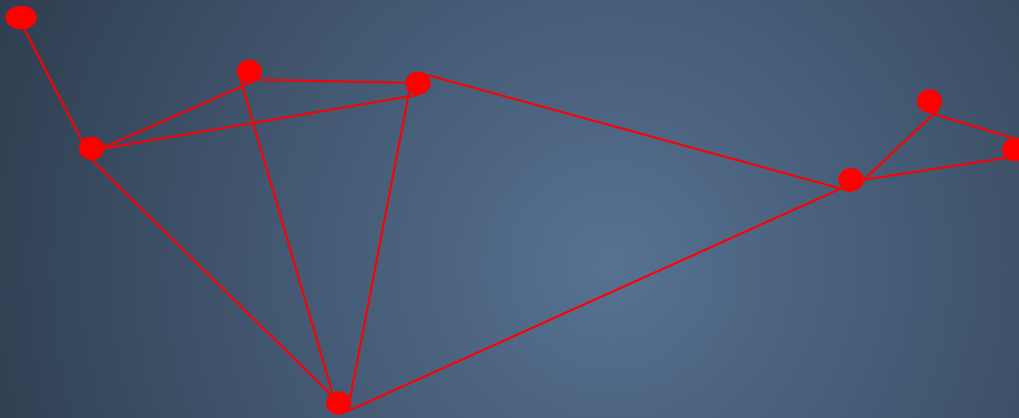# Baghdad, 2007 (urban terrain)
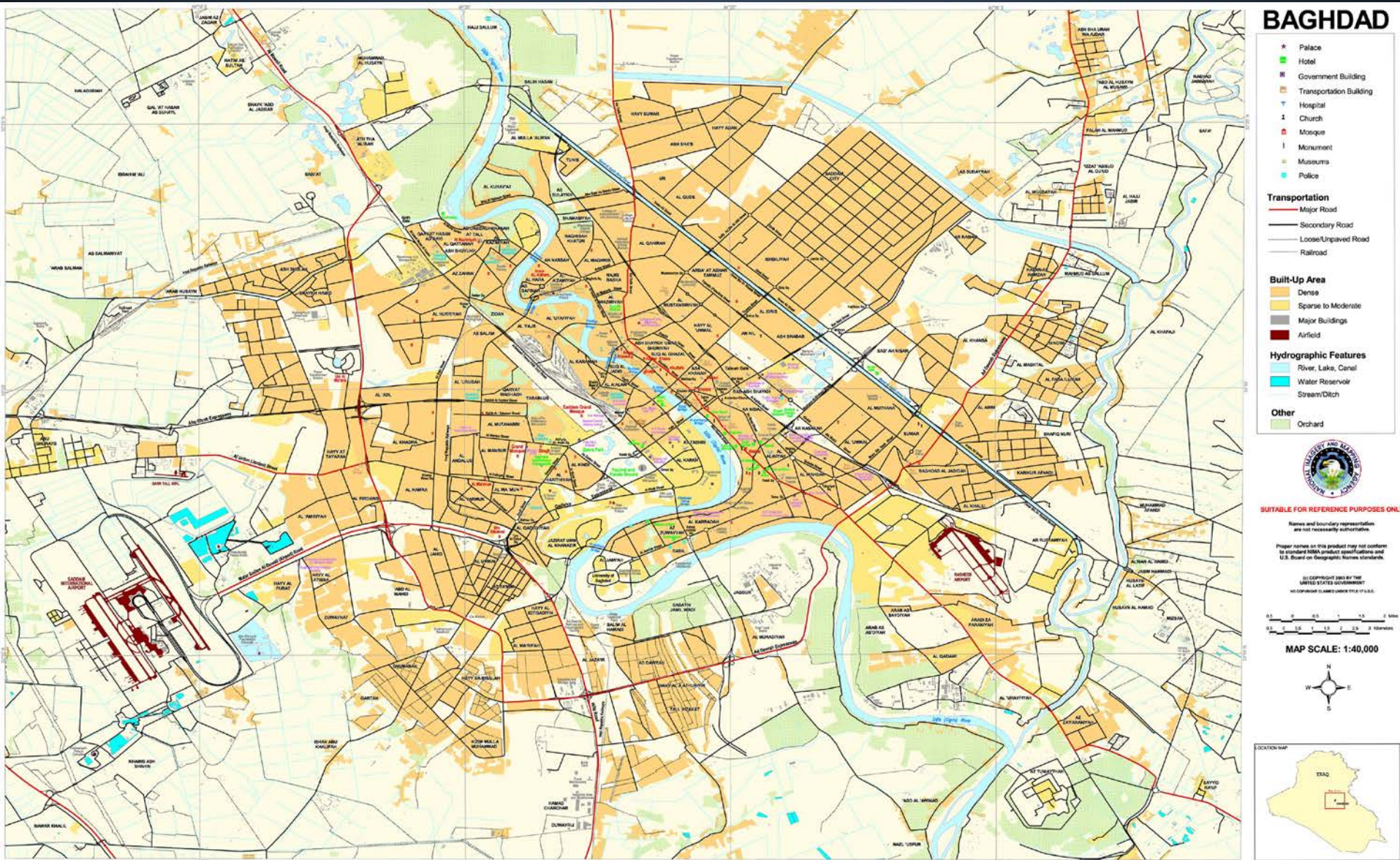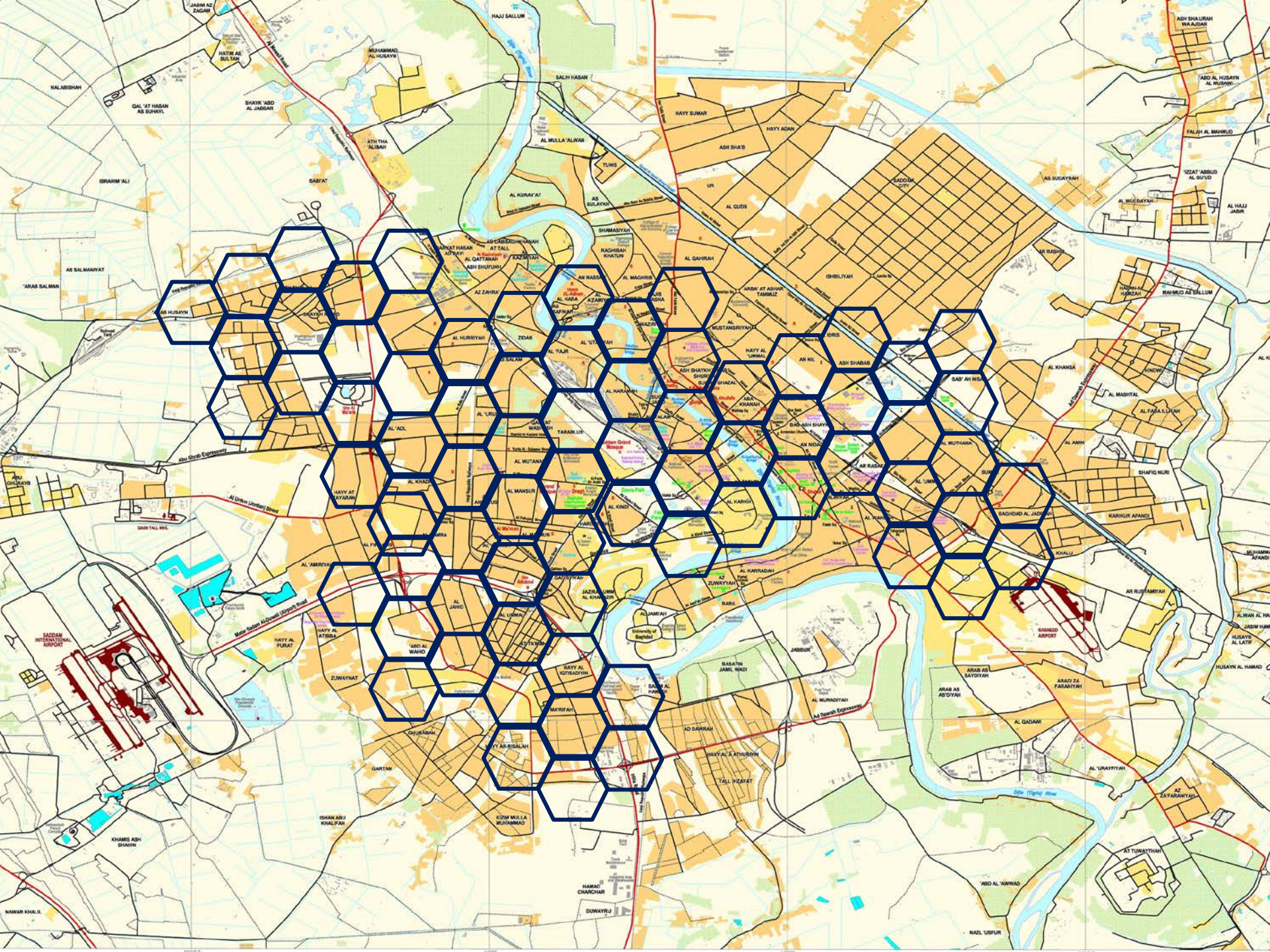
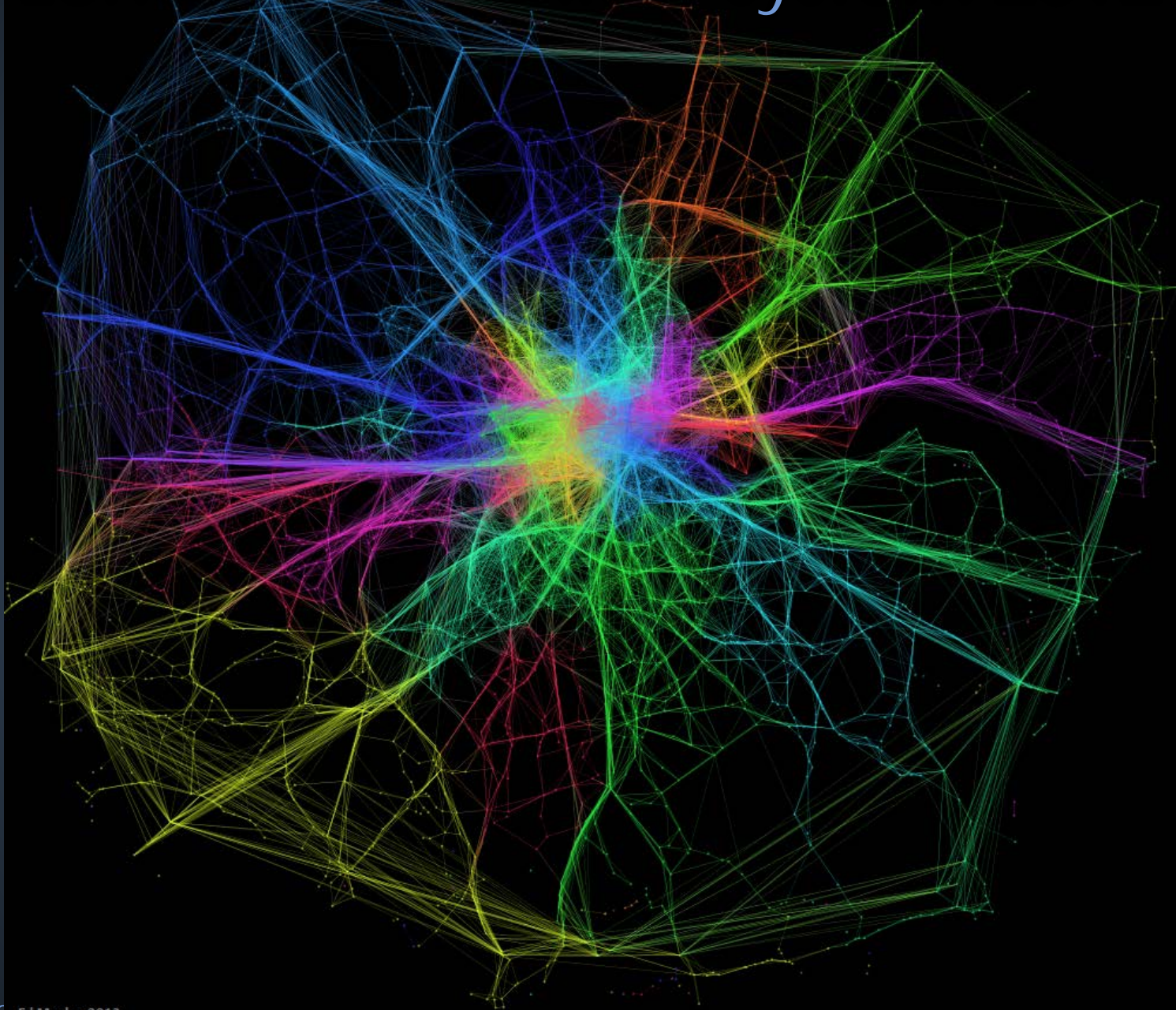# Urban terrain density mapping (Baghdad)
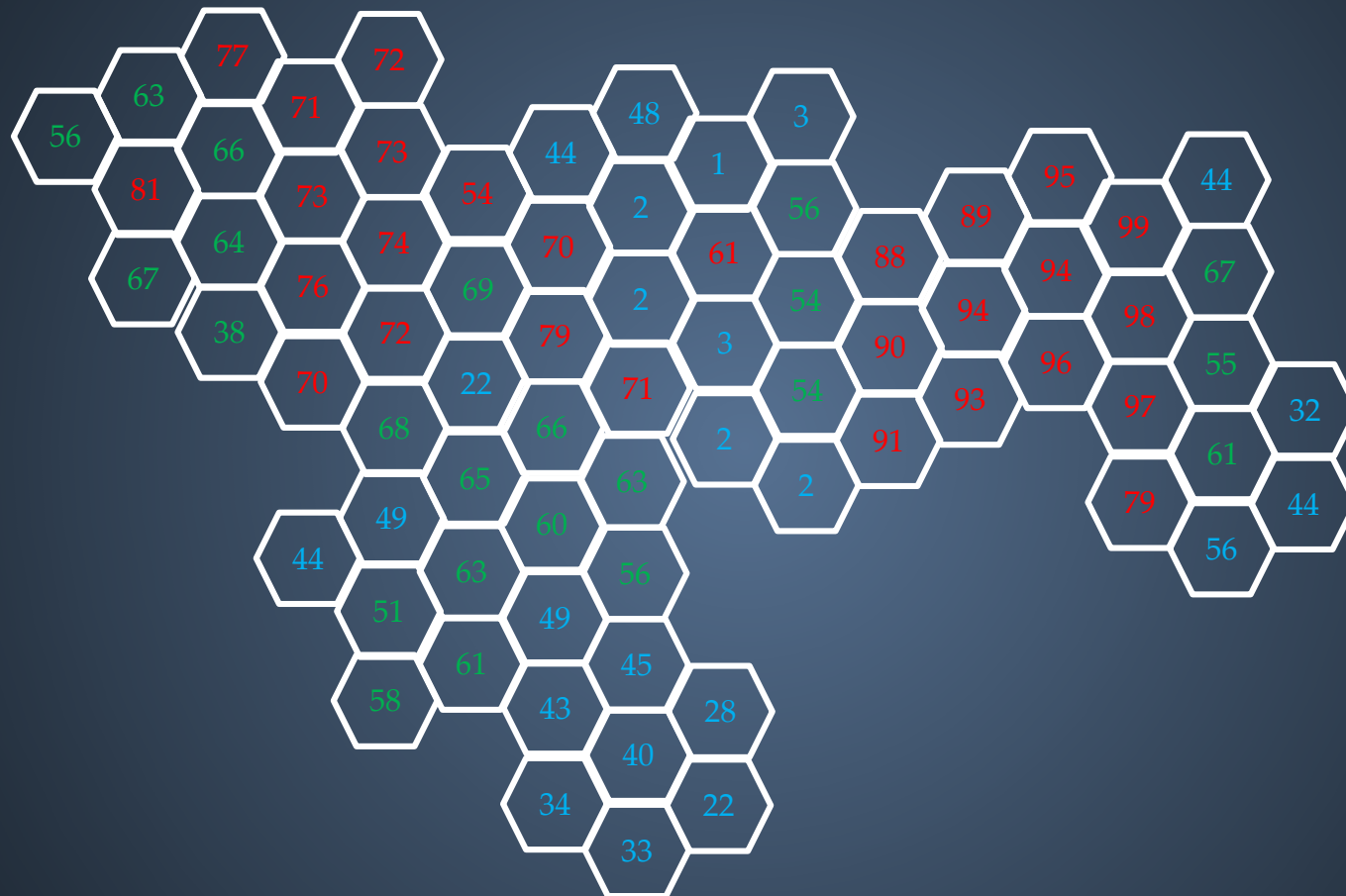
Urban nodal matrix (Baghdad)

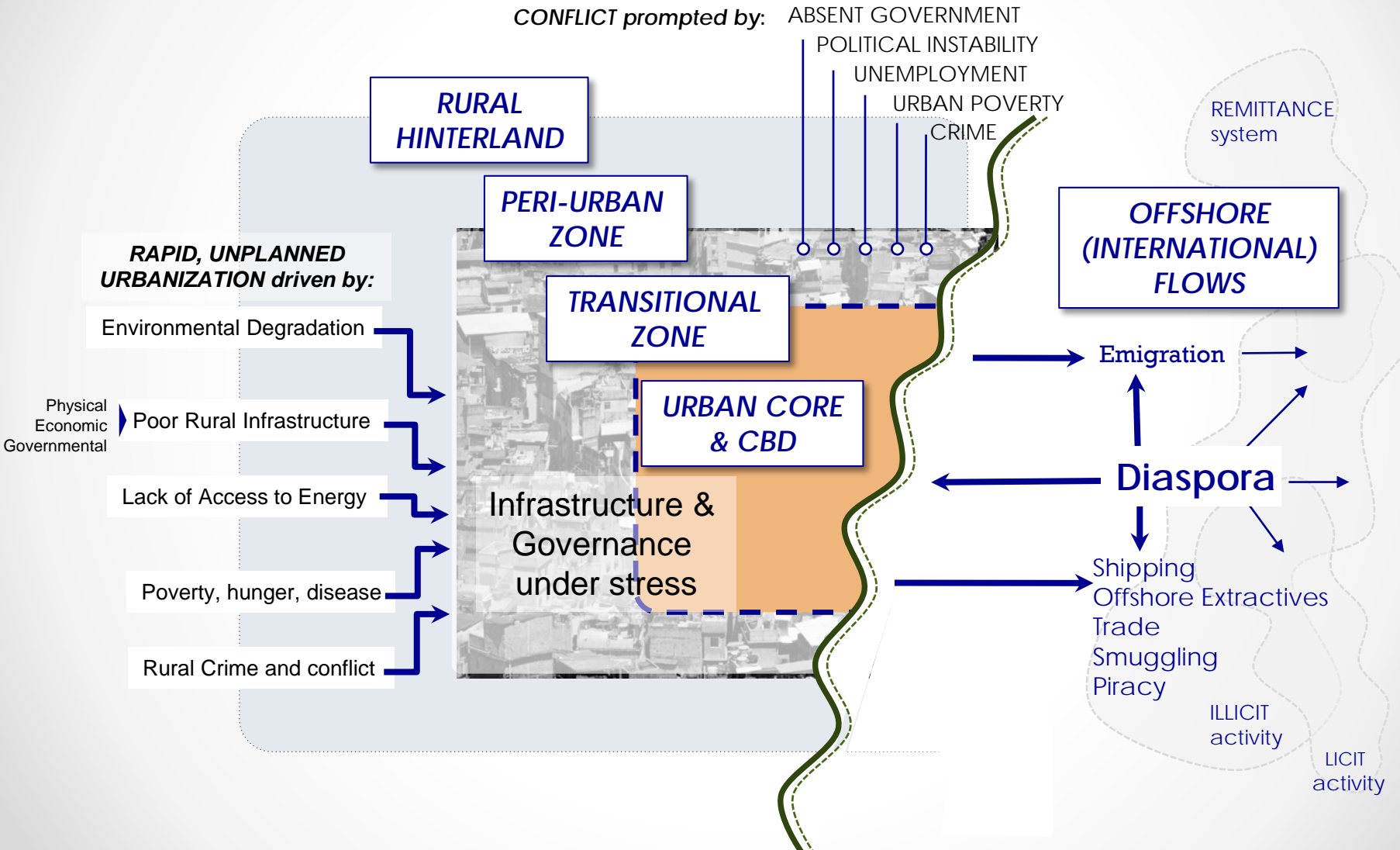# Urban nodal matrix (Baghdad)—2

Urban nodal matrix (Baghdad)—3

London traffic-flow system 2012

Ed Manley 2012
urbanmovements.posterous.com

3.
Cities as Systems

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The City as a System

CONFLICT prompted by: ABSENT GOVERNMENT
POLITICAL INSTABILITY
UNEMPLOYMENT
URBAN POVERTY
CRIME

RURAL HINTERLAND

PERI-URBAN ZONE

TRANSITIONAL ZONE

URBAN CORE & CBD

RAPID, UNPLANNED URBANIZATION driven by:

Environmental Degradation

Physical
Economic
Governmental

Poor Rural Infrastructure

Lack of Access to Energy

Poverty, hunger, disease

Rural Crime and conflict

Infrastructure & Governance under stress

OFFSHORE (INTERNATIONAL) FLOWS

REMITTANCE system

Emigration

Diaspora

Shipping
Offshore Extractives
Trade
Smuggling
Piracy

ILLICIT activity

LICIT activity

Urban Metabolism—Wolman, 1965

In modern times, the idea of urban metabolism was re-popularized by Abel Wolman's 1965 article "The Metabolism of Cities," and his notion that **researchers can understand a city as a system by looking at its metabolic flows, via what is known as a material flow analysis**, has since become a standard academic approach.

It's usually applied to the ecological sustainability of cities (that is, the way cities use and transform inputs of water, carbon, air, food, and fuel, then deal with the resulting waste products).

The idea is that urban systems need enough carrying capacity to absorb, process, and deal with inputs and to process (metabolize) waste products, otherwise toxicity develops in the system and it begins to break down.

Kilcullen (2012), 42

Urban Metabolism—Kilcullen, 2012

In recent years, though, people have started applying [Wolman's] concept more broadly, looking at **nonmaterial flows and systems in cities** as a way to examine the "relationships between social and natural systems, cities and their hinterlands (both immediate and global) and sustainability and social justice in urban areas."

Researchers in the fields of human geography and political ecology have built what we might call "**urban social metabolism**" **models, which explore flows of population, money, trade goods, and information into a city, trying to understand how the urban area transforms these inputs, and analyzing the ways that cities manage the by-products of that transformation—including economic inequality, crime, conflict, social disruption and exclusion, political alienation, social injustice, violence, and unrest**.

Analyses of this sort help us understand the carrying capacity of a city's governance systems, along with its physical infrastructure, and in turn to understand the city's stability, sustainability, and resilience. This approach also helps illuminate what we might call the territorial logic—more broadly, the systems logic—of urban environments, and in turn helps us think about the sustainability of urban systems.

Kilcullen (2012), 43

Modeling urban metabolism

INFLOW

RURAL HINTERLAND

PERI-URBAN ZONE

TRANSITIONAL ZONE

URBAN CORE & CBD

Inputs

Inputs

Metabolic Processes

Energy

Biomass

Waste

Waste

OUTFLOW
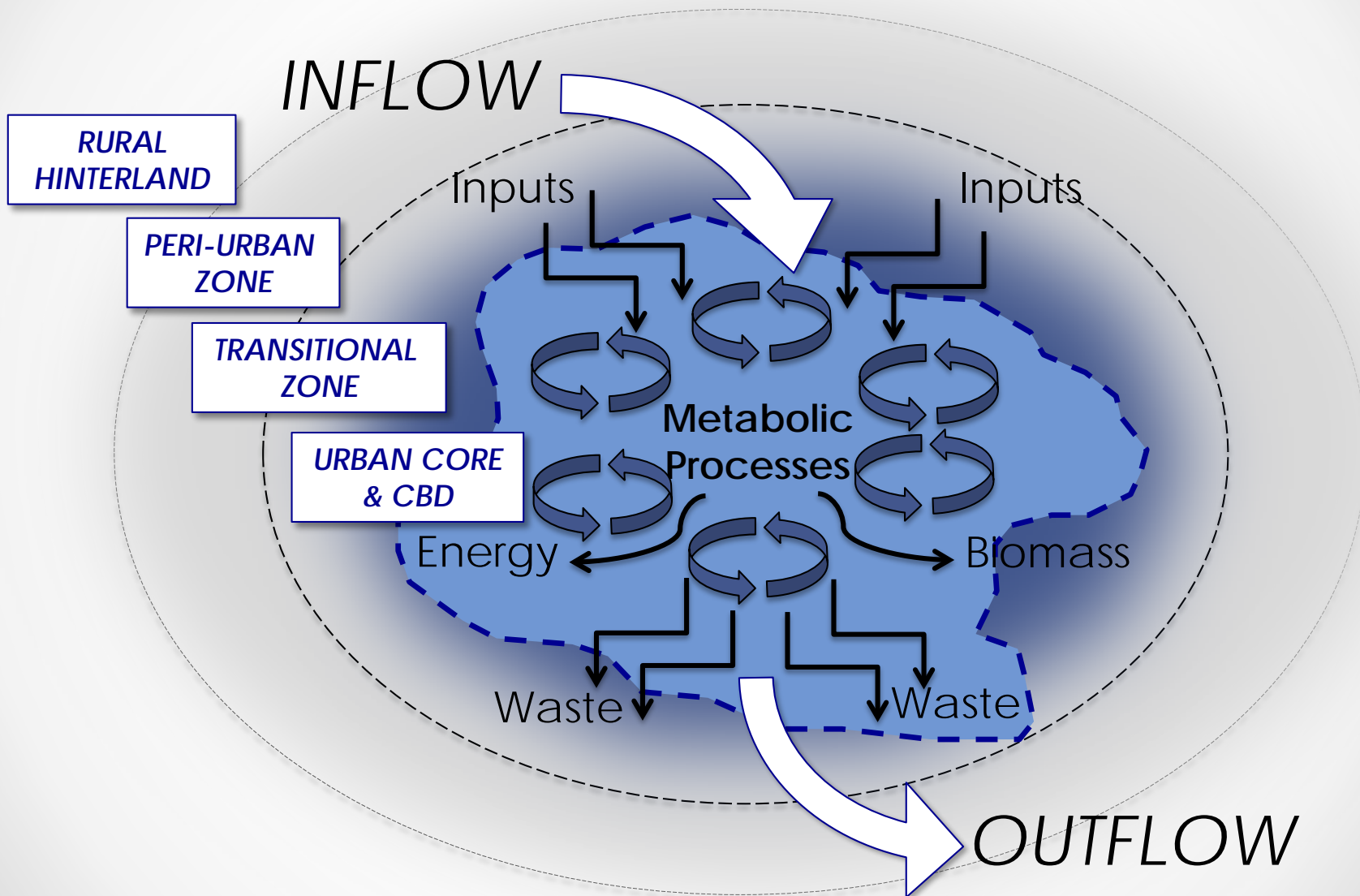
Rotterdam: Urban Metabolism (trade)

Oil and oil products
- Refineries
- Refinery terminals
- Tank terminals for oil products

Chemicals, biofuels and edible oils
- Chemicals manufacturers
- Biofuels manufacturers
- Edible oils refineries
- Tank terminals for chemicals, biofuels and edible oils

Gas and power, coal and biomass
- Gas fired
- Coal and biomass fired
- Renewables
- Natural gas terminals
- Coal and biomass terminals
- Dry bulk
- Liquid bulk
- Distribution
- Other activities
- Utilities

Containers
- Container terminal
- Container empty depot

Routes
- Train
- Cargo

Performance
- shop
- Harbour district
- Business district
- Ship intensity
- Motorway intensity

Harbour bussiness in central Rotterdam
- Maritime service
- Shipping companies
- Chemical company
- Metal treatment company
- Ship building and maintenance

1:100 000

Rotterdam: Urban Metabolism (energy)
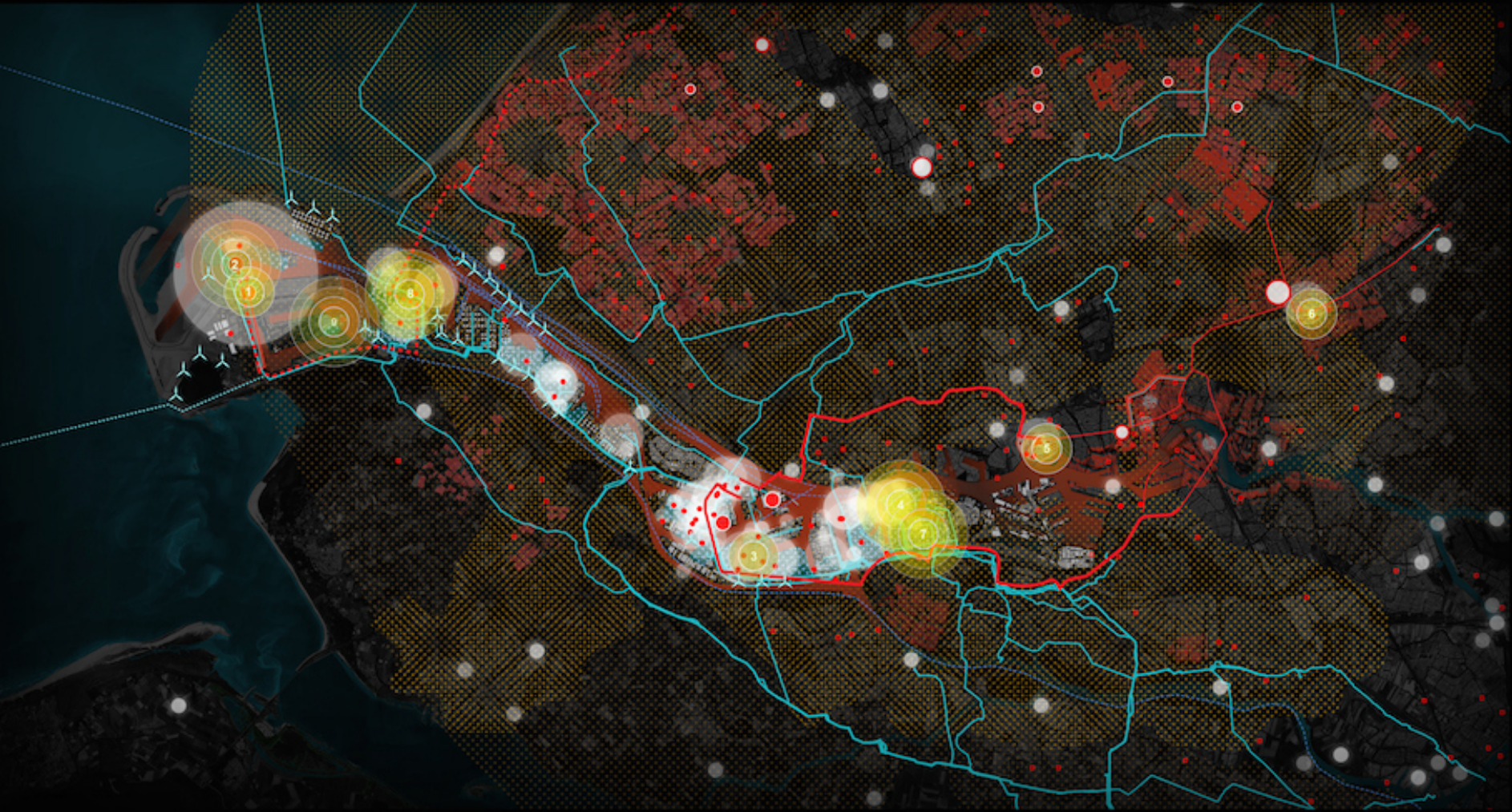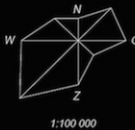
Surface water systems
- Salt water (-20m - -5m)
- River gradient salt-sweet
- Lower irrigation/discharge
- Fresh water basins
- Dredge disposal
- Drinking water basin

Drainage system
- Primary pumps
- Secondary pumps
- Primary inlets
- Existing movable flood barrier
- New movable flood barrier
- Dikes
- Overflow outlet points

Salination (in m. below NAP)
- Above NAP
- 5 - 0
- 10 - 5
- 25 - 10
- 50 - 25
- 100 - 50
- 200 - 100
- 300 - 200

Separate sewage (construction year)
- < = 1950
- 1951 - 1960
- 1961 - 1970
- 1971 - 1980
- 1981 - 1990
- 1991 - 2000
- 2001 - 2010
- 2011 - now

Sources
Evides
De Bosatlas voor ondergronds Nederland
TU Delft - Kennis voor klimaat
Municipality of Rotterdam

1:100 000

"The world is becoming a planet of slums"
—Mike Davis

Informal Settlements as Complex Systems

"From a design point of view, informality is a condition of complex, non-linear systems in which patterns overlap, intersect, and mutate in unexpected ways. Flexibility is the common ground among these approaches, a model of organic development that challenges the assumption of traditional Western planning that man controls his surroundings.

In contrast, patterns of development evident in informal settlements [...] are 'emergent', which assumes the absence of an identifiable author or agent; creation is either entirely spontaneous or generated by many convergent factors."

Brillenbourg, Feireiss and Klumpner 2005, 43

Makoko, Nigeria

Peri-urban settlements in littoral cities may be "floating" slums that straddle land/sea domains

Feral cities and "rogue urbanism"

Floor Area Ratio (FAR) vs Stacked Population Index (SPI)
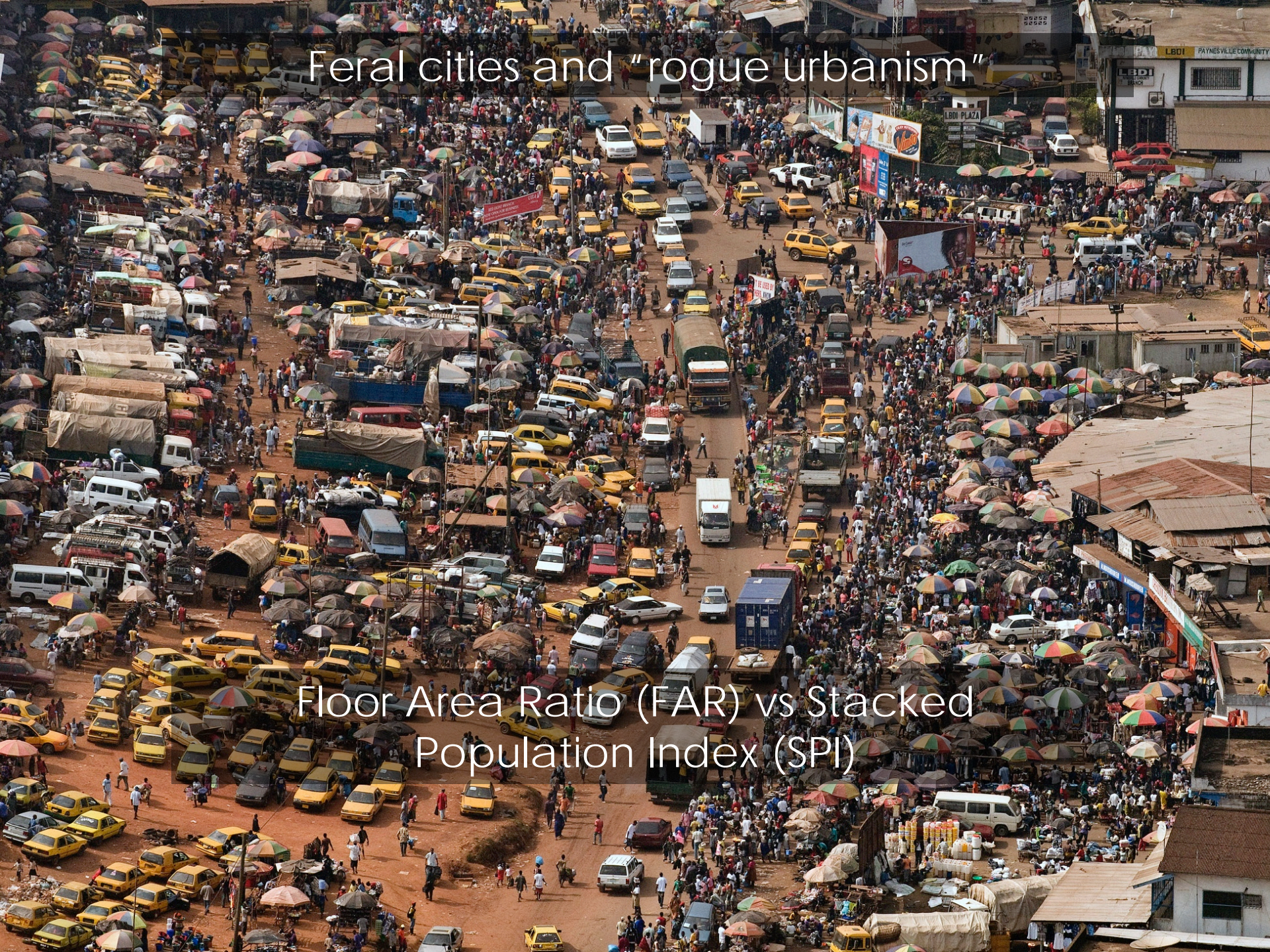
Urban system footprints

- Urban diasporas (global and national) + networked connectivity mean that the system footprint of an urban agglomeration is not equivalent to its physical (terrain) footprint

- Each city has a zone of influence akin to a gravitational field; cities interact with each other in a nested system-of-systems as part of a dynamic network of patterned material and non-material flows

- Urban system footprints are not equivalent to urbanized terrain, and can be analyzed, mapped and accessed to influence the city as a system

If we think of it as simply a piece of urbanized terrain, "Hargeisa" is a town of roughly 1.2 million people in the north-western Horn of Africa...But the real city is vastly more than that. If, instead, we consider Hargeisa as a *system*, with the city's relatively small area of urbanized terrain sitting at the centre of a vast social, political and economic ecosystem that includes not just the town itself but also its diaspora, connected to their city through remittances, e-banking, mobile telephones, Skype, social media, family ties, business deals, visits and investments—then we have a much clearer idea of what the city is and how its political economy works.

In effect, the human and communication networks and financial flows centred on the city, invisible though they may be, are its lifeblood, even though many nodes in these networks are not physically in Hargeisa at all.
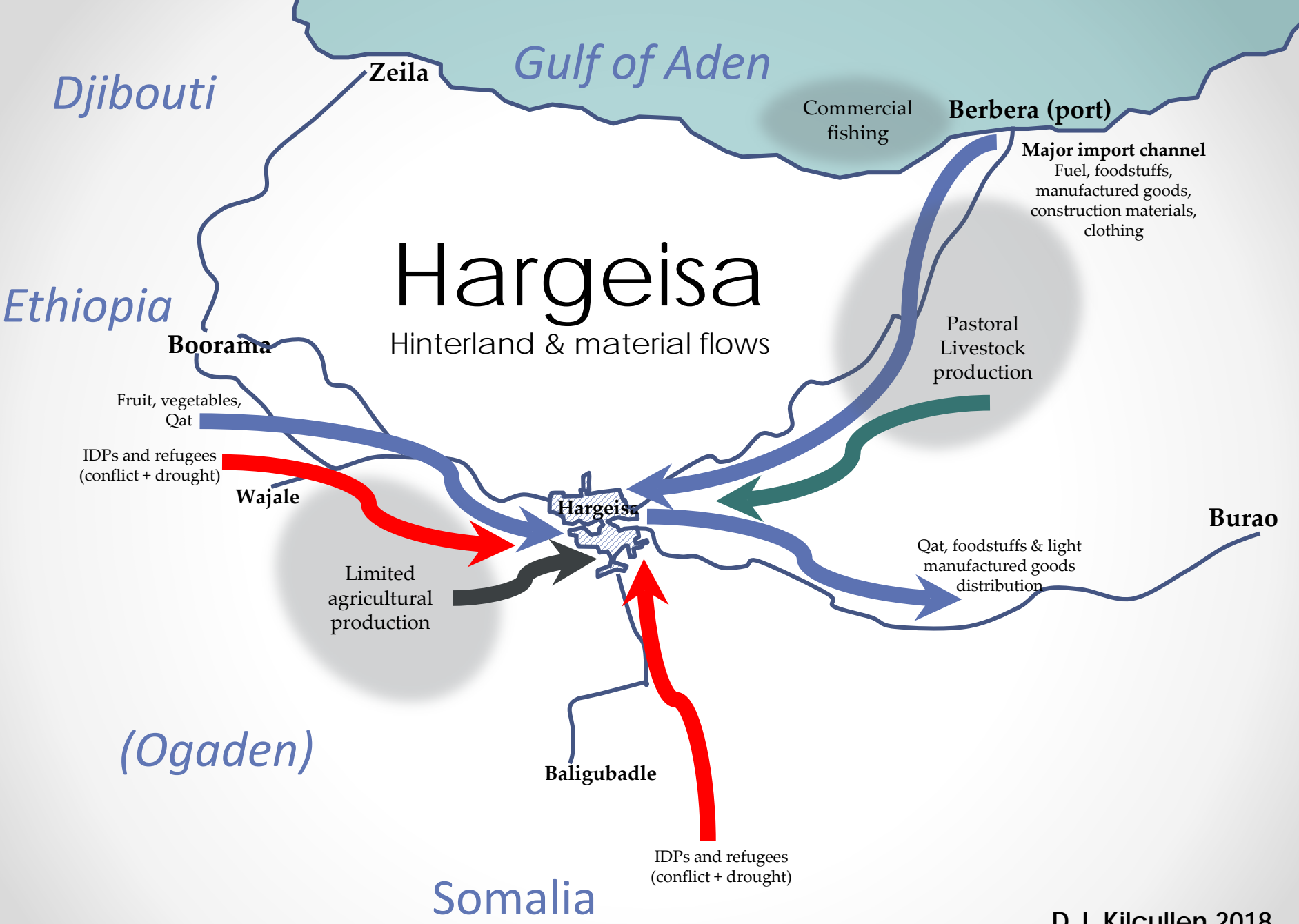
On a map of this real but invisible Hargeisa significant parts of the city, much of its population—and most of its wealth—are in Amsterdam, Cape Town, Copenhagen, Dubai, Durban, Düsseldorf, Helsinki, London, Minneapolis, Nairobi, Oslo, Portland, Seattle, Sydney and Toronto.
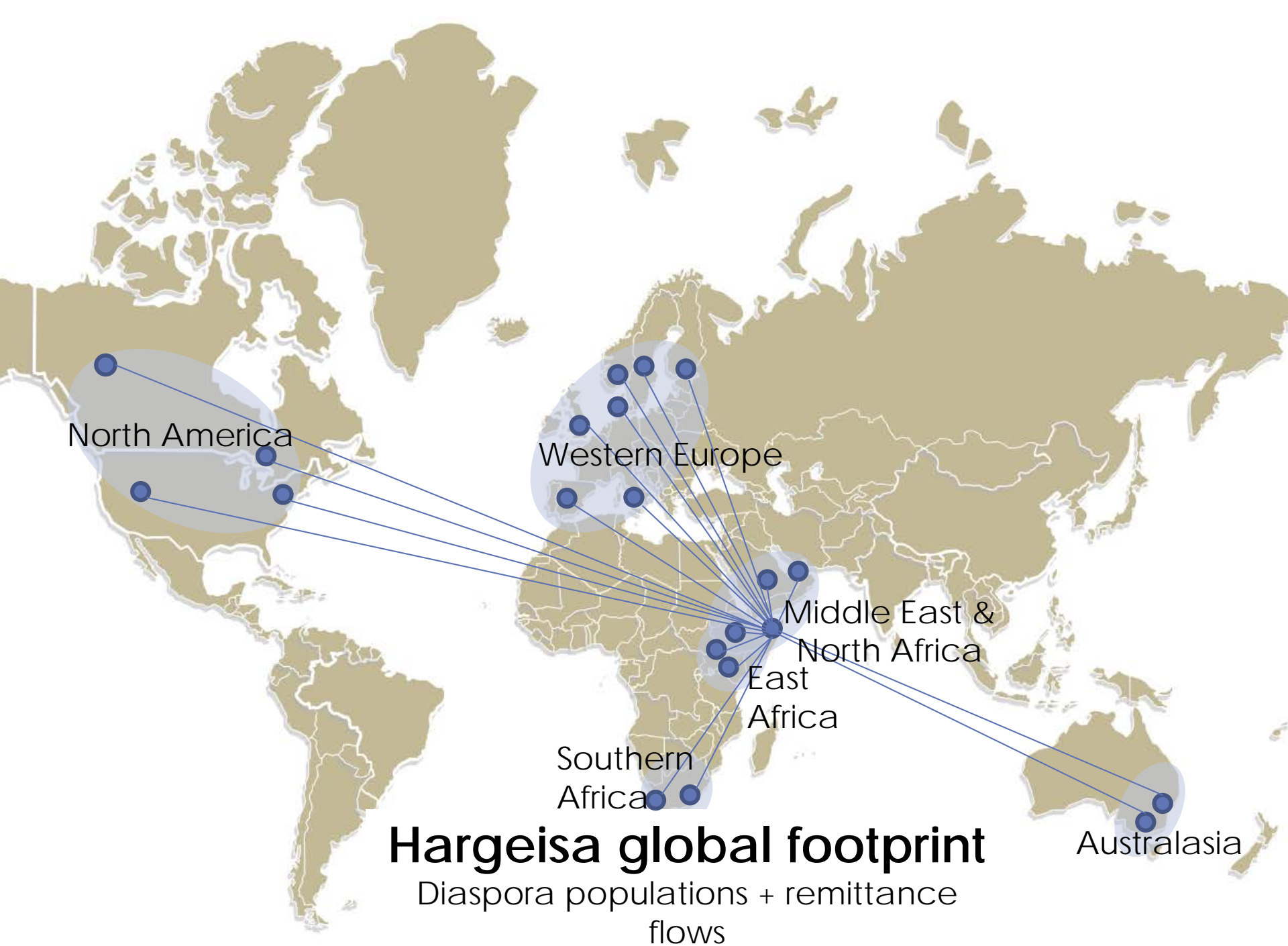
David Kilcullen (2018) *Hargeisa: Invisible City,* Johannesburg: Brenthurst Foundation

Hargeisa, Somaliland

Urban Schematic (Terrain footprint)

to Dhagax Warabe

to Berbera

Cemetery

to Wajale &
Boorama

to Burao

Maroodi Jeex
("Elephant Creek")
intermittent

N

| 0 | 1 | 2 | 3 |
Kilometres

Lat. Long.: 9.558038 N, 44.066930 E (centroid)
Elevation: 4.423' AMSL

Airport

Single runway 12,139'

to
Baligubadle

© **D.J. Kilcullen 2018**

Basemap: Google Satellite image
Validated via field research Nov 18

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North America

Western Europe

Middle East &
North Africa

East
Africa

Southern
Africa

Australasia

Hargeisa global footprint
Diaspora populations + remittance
flows

3.
Application and Implications

Control by flow manipulation—Graham 2006

Increasingly, both formal and informal political violence center on the deliberate destruction, or manipulation, of the everyday urban infrastructures that are necessary to sustain the circulations and metabolism of modern urban life. As urban life becomes ever more mediated by fixed, sunken structures, so the forced denial of flow, and circulation, becomes a powerful political and military weapon…

The mediation of contemporary urban societies by vast arrays of technological computerized systems of flow means that small disruptions and disablement can have enormous, cascading effects (Zimmerman, 2001; Little, 2002). As societies urbanize and modernize, so their populations become ever-more dependent on **complex, distanciated systems** for the sustenance of the political ecological arrangements necessary to sustain life (water, waste, food, medicine, goods, commodities, energy, communications, transport, and so on).

With pervasive, but uneven, computerization, software systems increasingly provide the functionalities that enable these multiple, networked systems to operate. This tends to accentuate the vulnerability of such "big" socio-technical systems, because the code can be easily manipulated from afar. (Thrift and French, 2002).
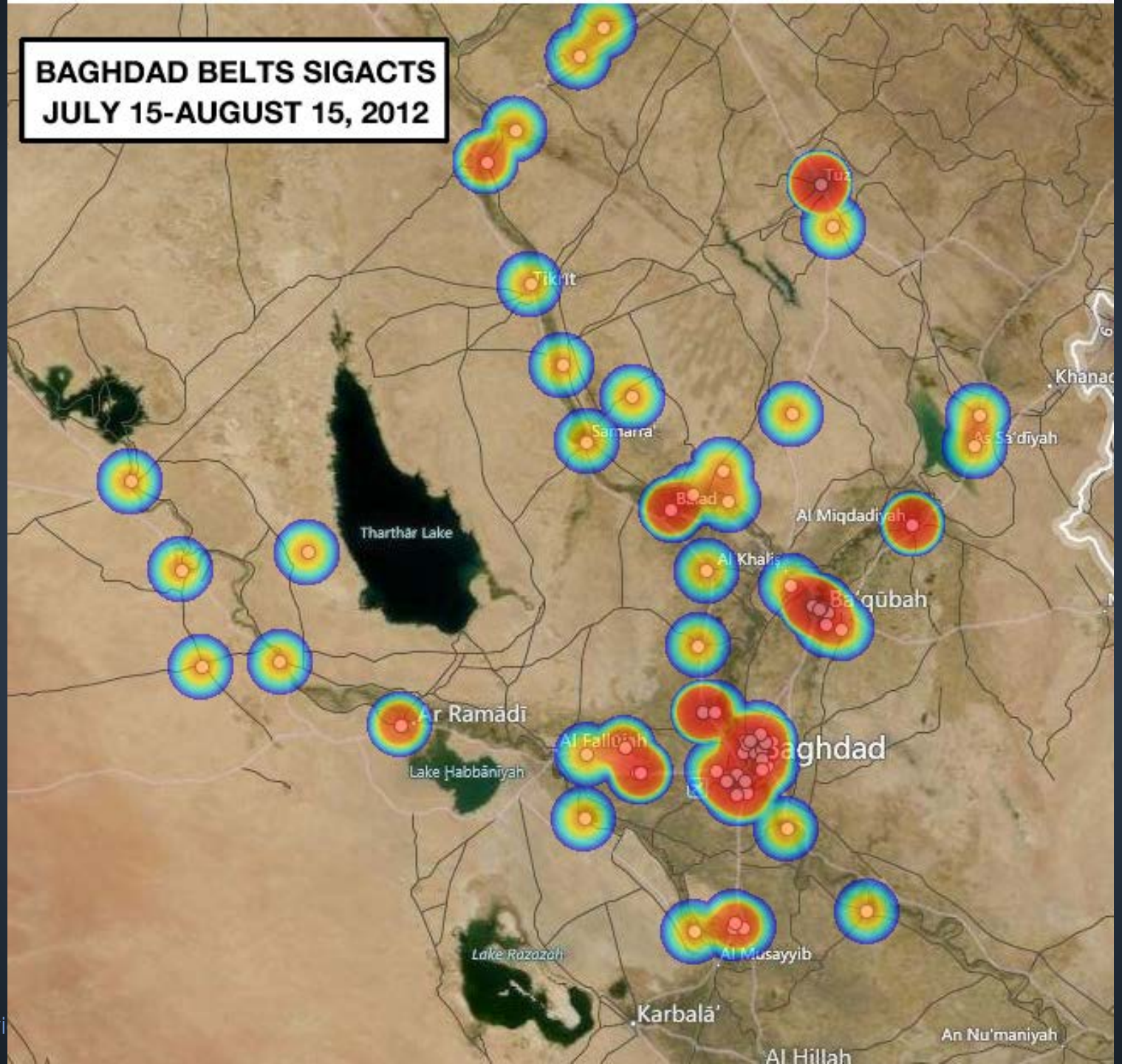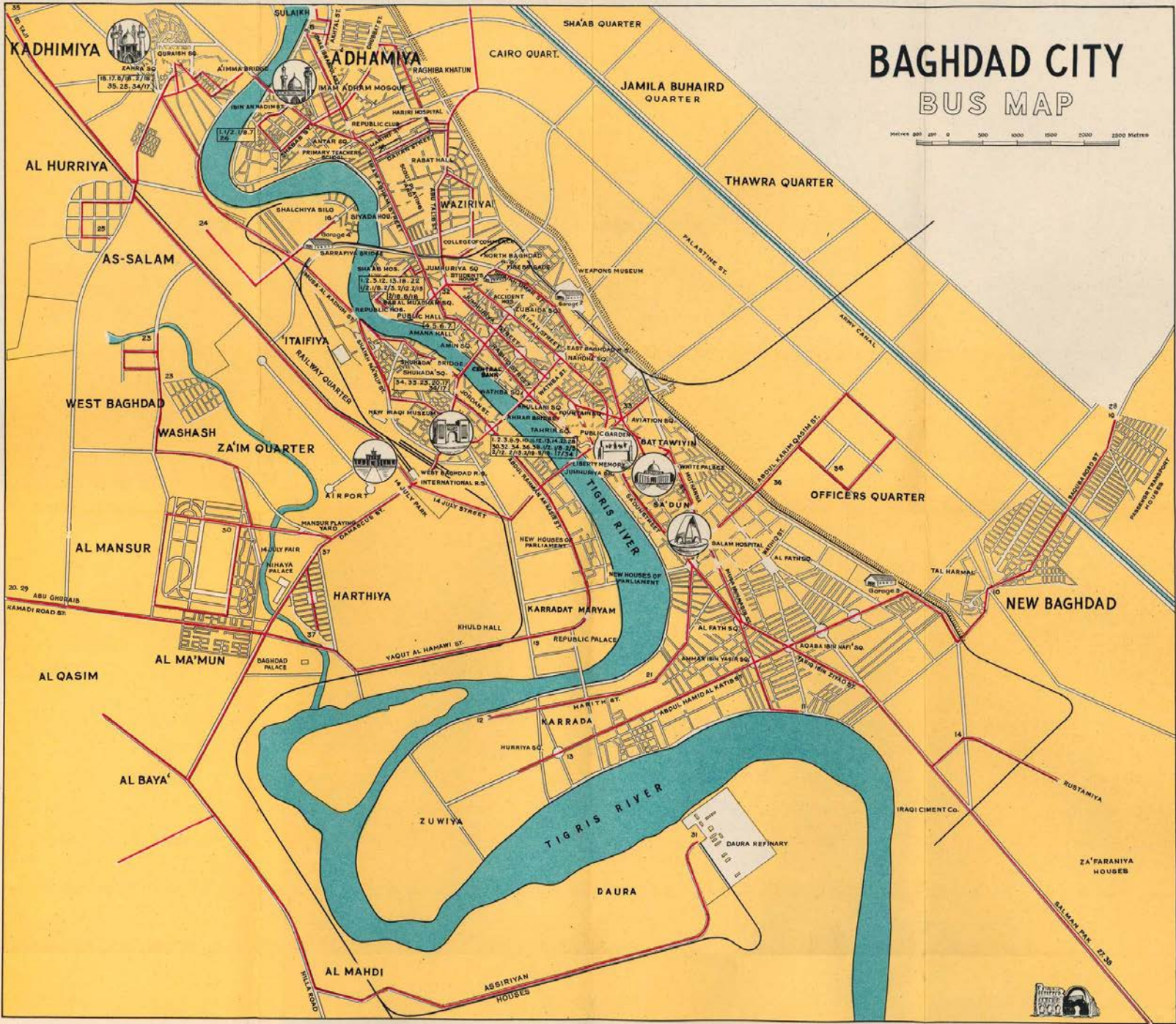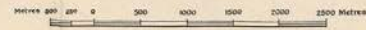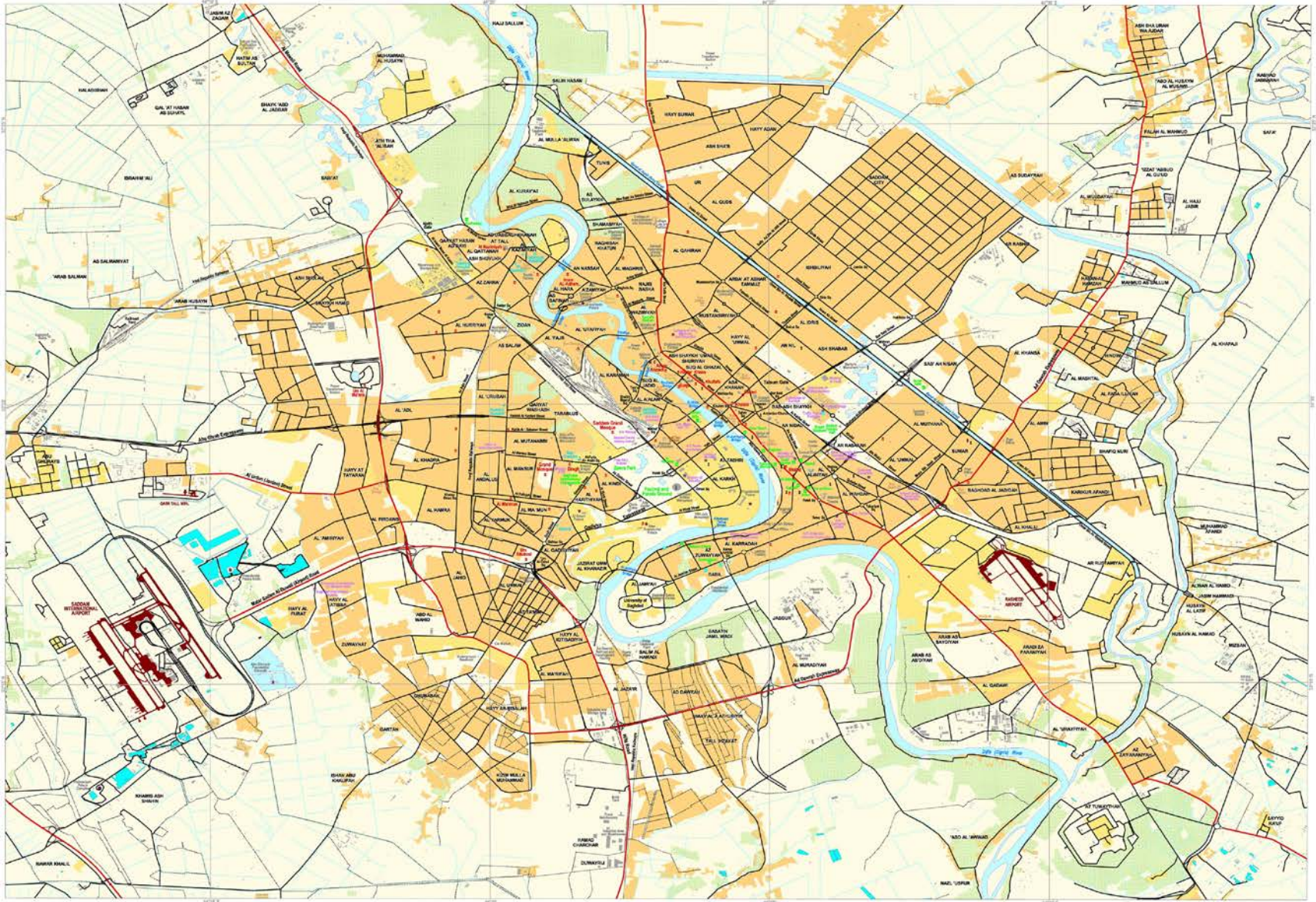
Graham (2006), 247
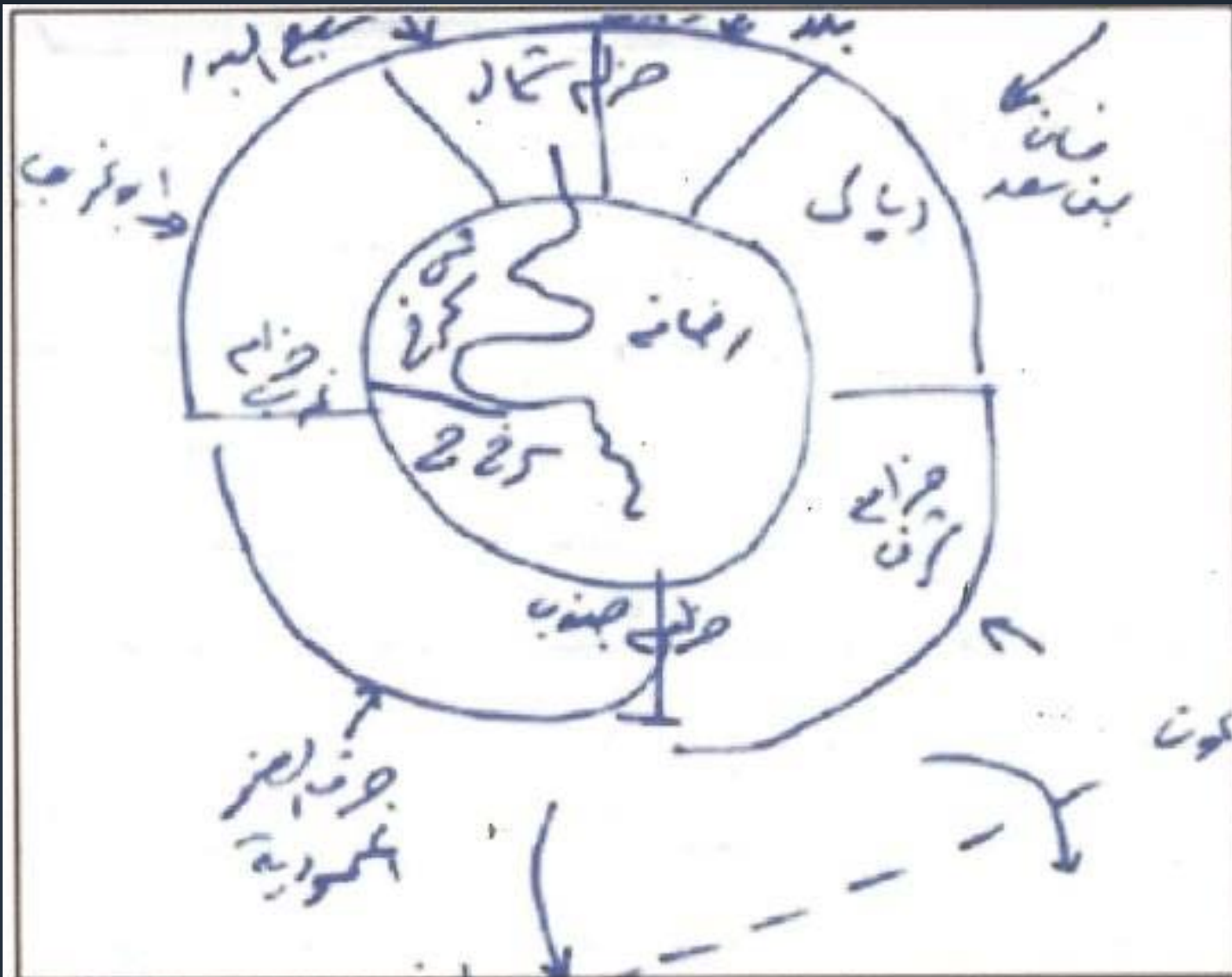
"Battle of the Baghdad Belt"

BAGHDAD BELTS SIGACTS
JULY 15-AUGUST 15, 2012

BAGHDAD CITY
BUS MAP

KADHIMIYA

ADHAMIYA

SULAIKH

SHA'AB QUARTER

CAIRO QUART.

JAMILA BUHAIRD QUARTER

AL HURRIYA

THAWRA QUARTER

AS-SALAM

WAZIRIYA

'ITAIFIYA

RAILWAY QUARTER

WEST BAGHDAD

WASHASH

ZA'IM QUARTER

PALESTINE ST.

WEAPONS MUSEUM

ARMY CANAL

OFFICERS QUARTER

AL MANSUR

AIRPORT

14 JULY STREET

HARTHIYA

TIGRIS RIVER

SA'DUN

BATTAWIYIN

WHITE PALACE

SALAM HOSPITAL

TAL HARMAL

NEW BAGHDAD

ABU GHURAIB

RAMADI ROAD ST.

AL MA'MUN

BAGHDAD PALACE

KARRADAT MARYAM

REPUBLIC PALACE

AL FATH SQ.

AL QASIM

KARRADA

HURRIYA SQ.

RUSTAMIYA

AL BAYA'

ZUWIYA

TIGRIS RIVER

DAURA REFINARY

IRAQI CIMENT Co.

ZA'FARANIYA HOUSES

DAURA

AL MAHDI

ASSIRIYAN HOUSES

SALMAN PAK

Metres 800 250 0 500 1000 1500 2000 2500 Metres

Urban targeting cycle

Next cycle of kinetic ops builds on knowledge from first cycle

4

1

Kinetic (cordon/search) ops in city district prompt enemy to flee to outlying villages

2

Non-kinetic ops in villages-of-origin detect and photograph newly arrived military age males

3

Community leaders in city district identify photos of military age males from village ops—allows link analysis

Implications

- Urban wormholes?

- Endless/edgeless cities

- Shrinking/hollow cities

- De-industrialization/de-urbanization

- Internal secession

- Participatory urbanism (rogue urbanism)

- Split cities, no-go areas

Questions and Discussion

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