URBAN GROWTH SCENARIOS

Hashemite Kingdom of Jordan

سيناريوهات النّمو الحَضري

المملكة الأردنية الهاشمية

2018

بسم الله الرحمن الرحيم

Ministry of Planning and International Cooperation

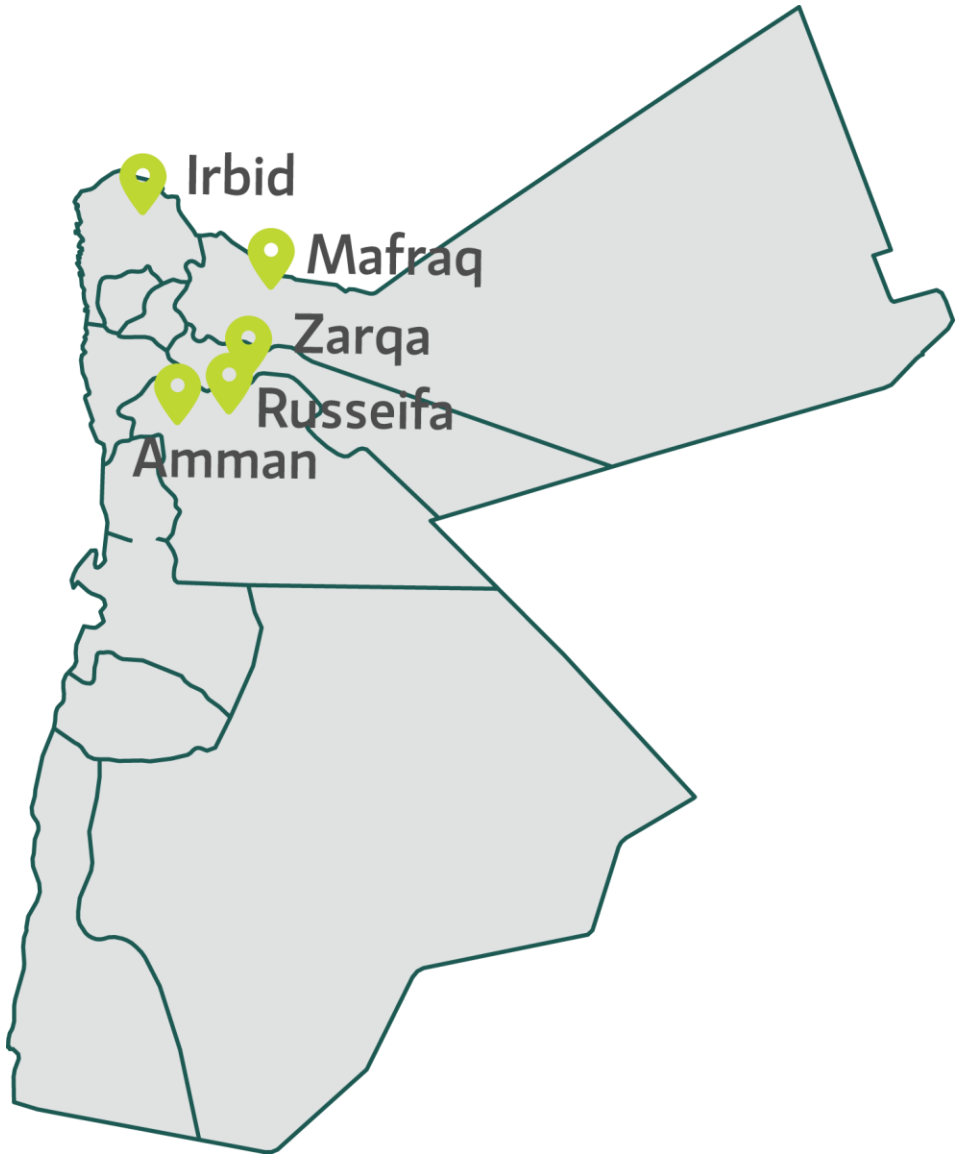
WORLD BANK GROUP

Korea Green Growth Trust Fund

CAPSUS Sustainable Capital

Urban Growth Scenarios for The Hashemite Kingdom of Jordan

This is a project developed in coordination with the Ministry of Planning and International Cooperation (MoPIC) and the Ministry of Municipal Affairs (MoMA) to **outline sustainable development paths** for five Jordanian cities: Amman, Irbid, Mafraq, Russeifa and Zarqa.



Duration: April to December 2017.

Objective

To **compare the environmental, social and economic impacts** of different urban growth paths for five Jordanian cities to guide the identification, preparation and implementation of sustainable urban investment projects.

Through the completion of the project, governments are expected to:

- Create **consensus** with stakeholders.
- Request **funding** from cooperation agencies.
- **Disseminate** the potential benefits of their projects.
- **Test** rough ideas and present solid proposals.
- **Convince** others by providing numerical data.

	Land consumption	Energy	GHG emissions	Infrastructure costs	Municipal services costs
BAU	km^2	kWh/capita/annum	$kgCO_2eq$/capita/annum	Millions of JD	JD / capita
MODERATE	km^2	kWh/capita/annum	$kgCO_2eq$/capita/annum	Millions of JD	JD / capita
COMPACT GROWTH	km^2	kWh/capita/annum	$kgCO_2eq$/capita/annum	Millions of JD	JD / capita
VISION	km^2	kWh/capita/annum	$kgCO_2eq$/capita/annum	Millions of JD	JD / capita

Three steps in our methodology

Identify problems and solutions, estimate indicators and disseminate the results

Decision makers explain the **problems** that their city is facing and the **solutions** that they are currently exploring.

A multidisciplinary team models the possible outcomes from the implementation of such solutions in a palette of **indicators**.

Decision makers use the outputs to:

* **Create consensus**
* **Request funding**
* **Disseminate potential benefits**

A long process with a large team

Technical staff of the five municipalities and LTRC, DOS, DLS, MoMA and MoPIC were involved.

13 workshops

110 meetings

10 months

14 Urban concerns

16 Policy levers

Source: CAPSUS photo archive 2017.

Data sources

Data from local governments was adapted and complemented with international sources.

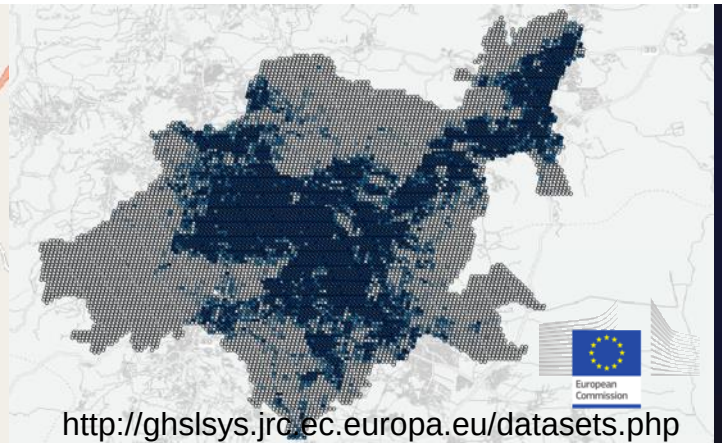
Local sources:

- Population and Housing Census, DOS 2015
- Population projections, DOS 2017
- Urban Master Plans, MoMA 2010 and GAM
- Shp files with public transport routes, LTRC 2010
- Shp files with location of urban amenities, MoMA and Municipalities
- Jordan Water Sector Facts & Figures, MoWI 2015
- NEPCO Annual Report, NEPCO 2016

International sources:

- Global Human Settlements Built-up Grid, European Commission JRC 2015
- Gross Domestic Product spatial distribution derived from night-lights satellite data, NOAA 2010
- Open Street Maps 2017

http://export.hotosm.org/en/



http://ghslsys.jrc.ec.europa.eu/datasets.php

https://ngdc.noaa.gov/eog/dmsp/download_gdp.html

Scenarios

		Public transport	Landmarks	Solid waste	Clean energy generation	Green Building Code	Efficient public lighting	Reduce hazards
BASE	Situation in 2015							
BAU	No policy levers. The city grows following historical trend.							
MASTER PLAN	Growth according to the Master Plan							
MODERATE	Growth according to the Master Plan +	Planned routes ✓	Planned ✓	Transfer station ✓		14% ✓	100% ✓	✓
COMPACT GROWTH	Compact growth							
VISION	Compact growth +	Planned + alternative routes ✓	Planned + alternative parks ✓	Transfer station ✓	10-16 MW ✓	70-90% New dwellings ✓	100% ✓	✓

Urban expansion modeling – BAU scenario

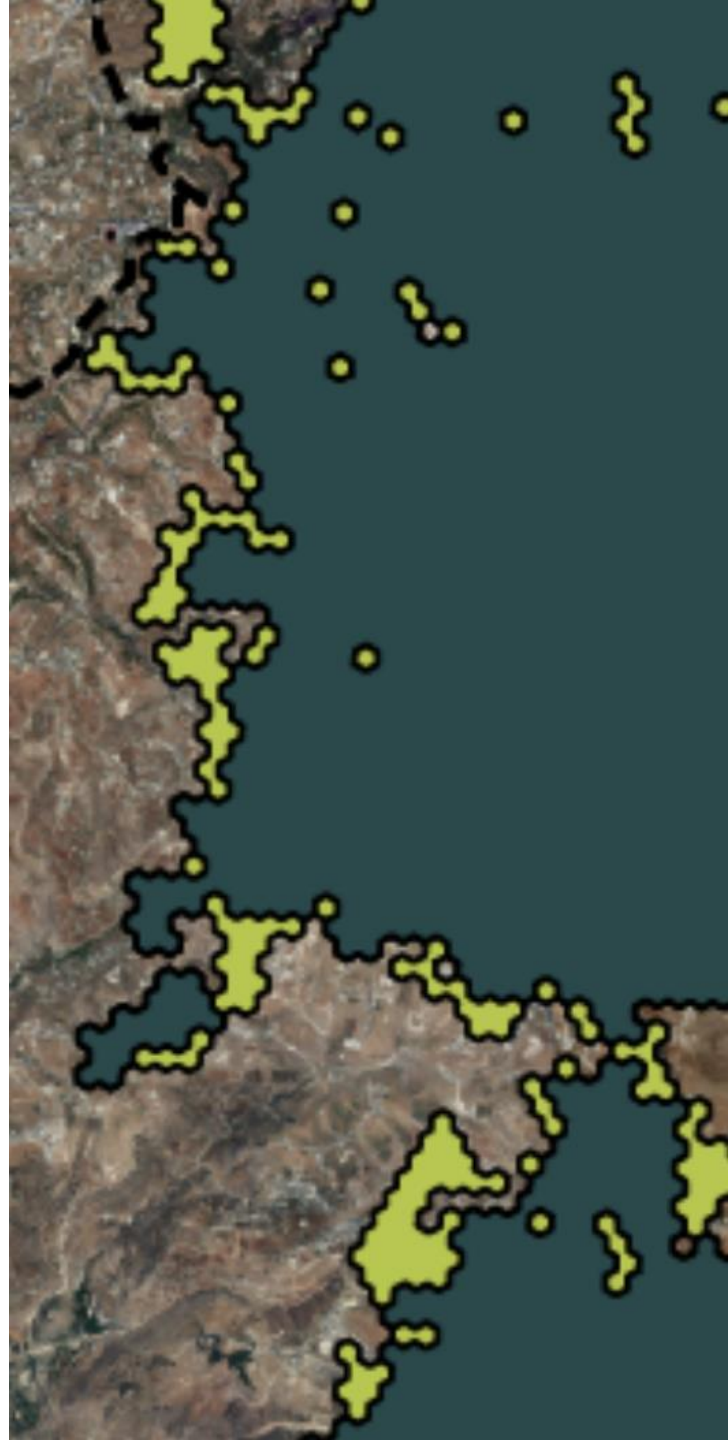
Machine learning algorithms predicted the expansion for the BAU scenario.

Three machine learning methods were used to model the expansion of the cities if past trends continue:

- Random Forest
- Extratrees
- Logistic Regression

City	Model	TN	TP	FP	FN	Number of units	Precision	Recall	F1
Amman	Extratrees	34713	4296	390	254	39653	0.91	0.94	0.93
	Random Forest	34696	4287	406	264	39653	0.91	0.94	0.92
	Logistic Regression	34684	4004	546	419	39653	0.9	0.87	0.89
Irbid	Extratrees	18378	1941	279	85	20683	0.87	0.95	0.91
	Random Forest	18399	1898	259	127	20683	0.88	0.93	0.9
	Logistic Regression	18374	1793	283	233	20683	0.86	0.88	0.87
Mafraq	Extratrees	4457	198	37	28	4720	0.84	0.87	0.85
	Random Forest	4443	203	51	23	4720	0.79	0.89	0.84
	Logistic Regression	4463	162	64	31	4720	0.84	0.7	0.76

TN: True negative TP: True Positive FP: False Positive FN: False negative



Urban expansion modeling – alternative scenarios

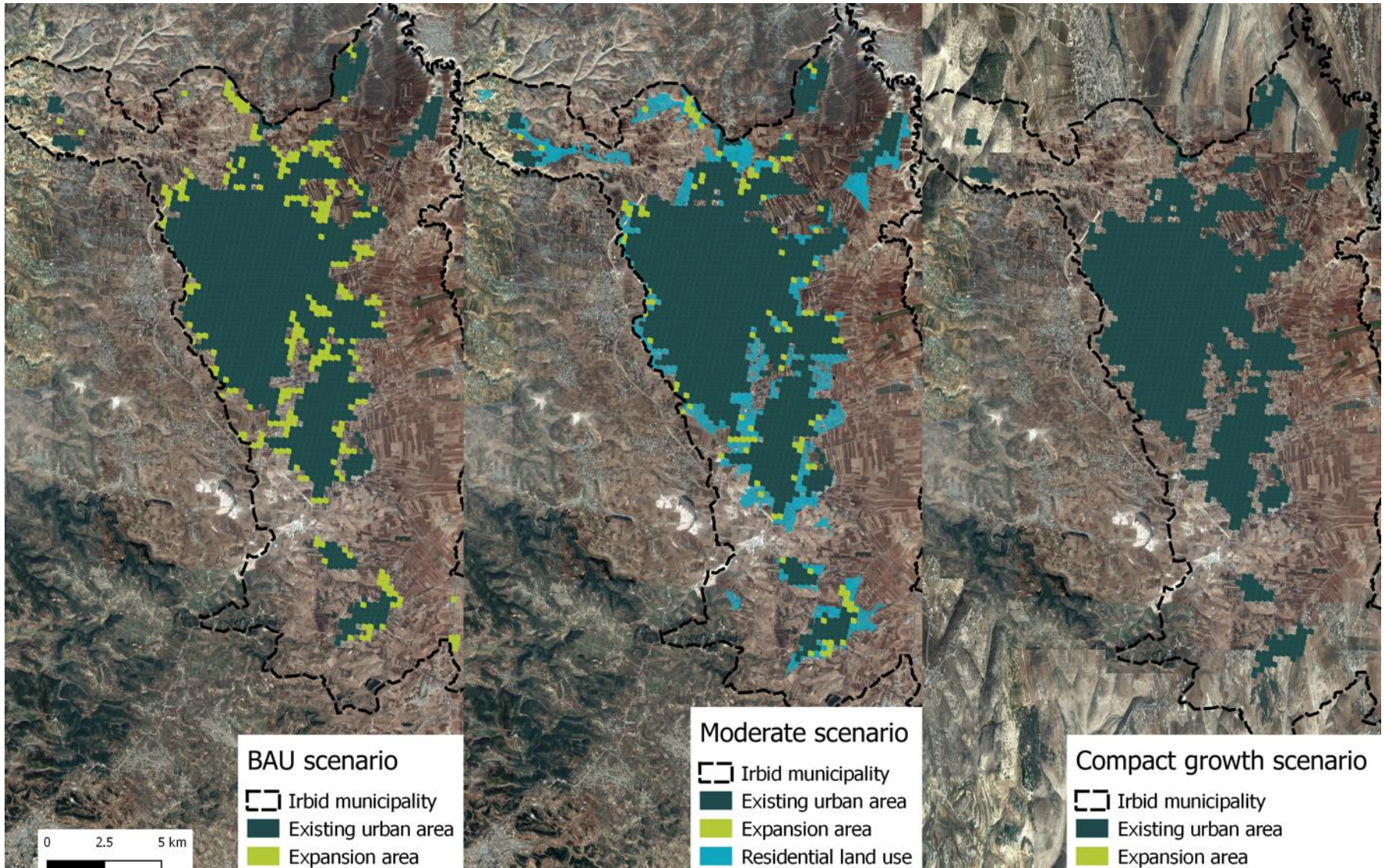
Programmatic modeling was used to create alternative urban growth paths.

Moderate scenario

- Human settlement is allowed only in zoned areas (no irregular settlement)

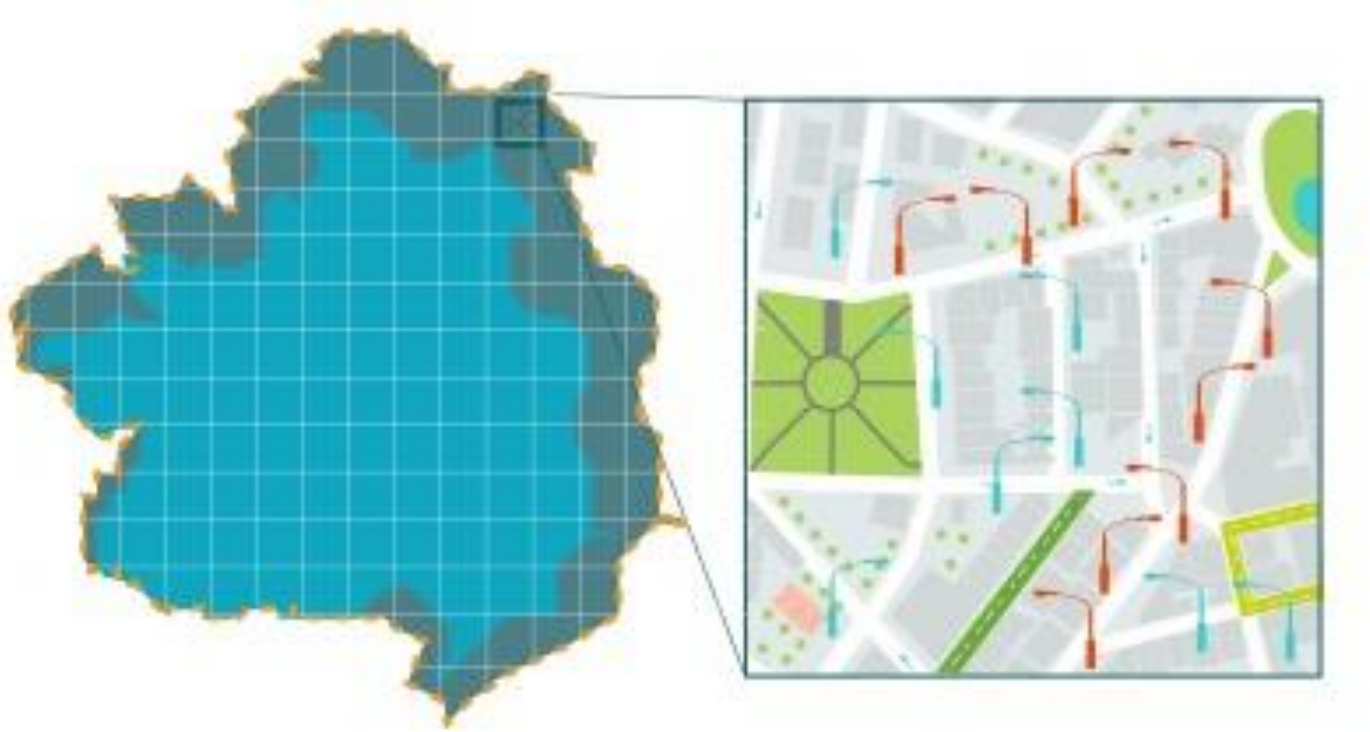
Compact growth scenario

- Vacant-housing rate is reduced (24% to 8%)
- New housing is prioritized near employment and transit



Indicators calculation methods

Calculation methods are designed considering the key variables modified in the different scenarios.



Kilowatts hour per person per year [kWh/person per yr]

Non-LED bulbs number (num_bulb)

LED number (num_led)

Total built-up area (footprint_km2)

Energy for public lighting

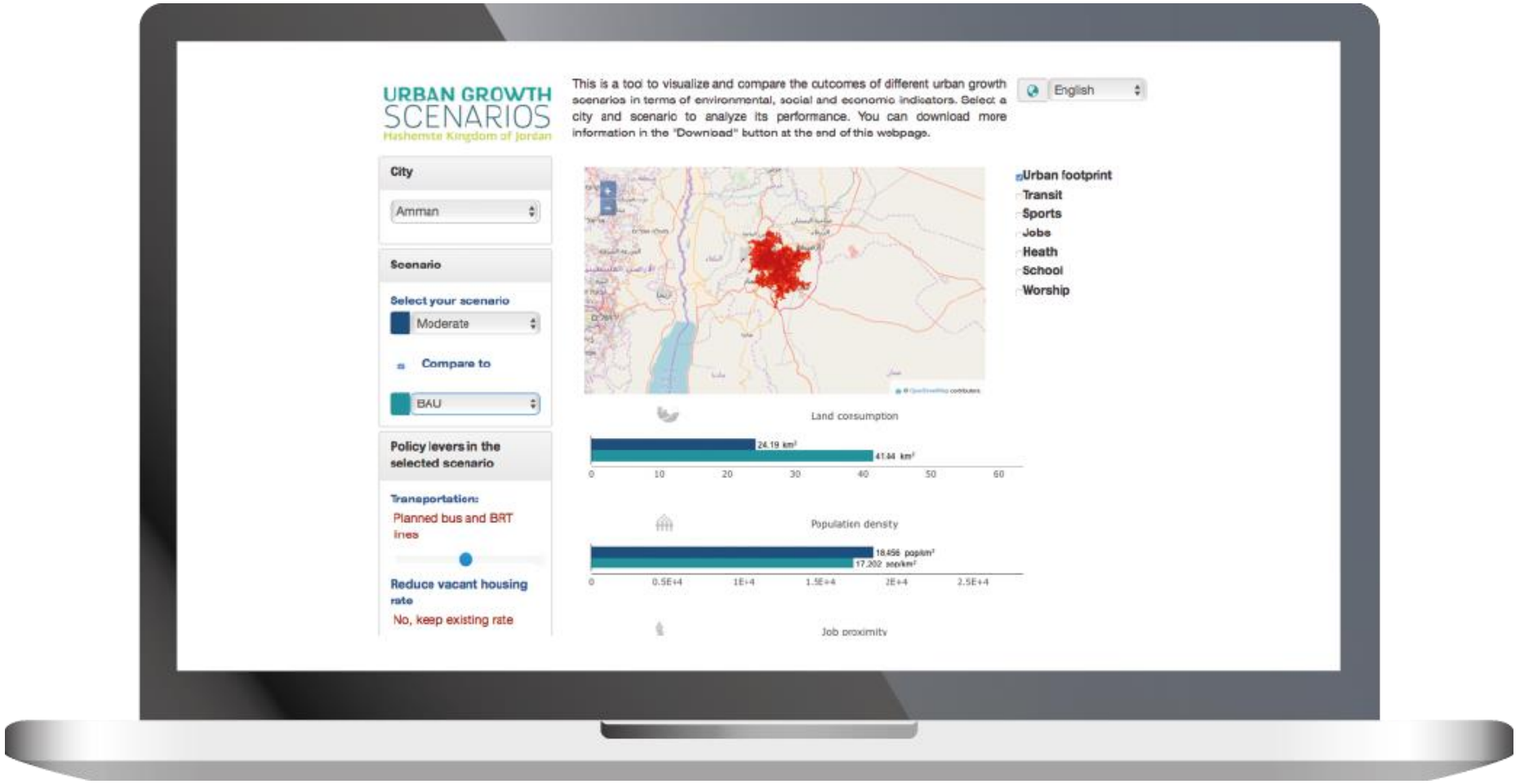
To estimate the energy saving due to replacing public lighting bulbs with **LED bulbs**, the key variable in the calculation method was the percentage of light bulbs that are LED. But, to reflect also how much energy will be needed to illuminate the **expansion area** of the city by 2030, the method should consider the kilometers of streets as one variable that could change depending on how much the city grows in each scenario.

IRBID

1,040,898 inhabitants by 2030

		Land consumption	Energy	GHG emissions	Infrastructure costs	Municipal services costs
BAU		17.19 km²	4,039 kWh/capita/annum	1,217 $kgCO_2eq$/capita/annum	97.38 Millions of JD	71 JD / capita
MODERATE	9 bus Planned 14% 1 TS 100% Artisanal	7.06 km²	3,895 kWh/capita/annum	1,177 $kgCO_2eq$/capita/annum	40.01 Millions of JD	60 JD / capita
COMPACT GROWTH		0.00 km²	3,573 kWh/capita/annum	1,077 $kgCO_2eq$/capita/annum	11.09 Millions of JD	58 JD / capita
VISION	9 bus Planned 70% 1 TS 100% Artisanal 16MW	0.00 km²	3,487 kWh/capita/annum	1,056 $kgCO_2eq$/capita/annum	10.93 Millions of JD	54 JD / capita

up.technology/up_jr



Future plans from local stakeholders

We expected a request for scaling-up the tool. But they found applications beyond our expectations.

At the end of the project, local stakeholders were particularly interested in:

- Developing a national-level tool to assess the sustainability of future Master Plans.
- Creating a geoportal, a web-based open platform for spatial data sharing which would foster collaboration and evidence-based urban planning.

Thanks!

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