

WATER SCARCITY

Examining Impacts Around the World

INTRODUCTION

- *Introduction*
- *Common Issues and Impacts*
- *Case Study: Yemen*
- *Case Study: Australia*
- *Case Study: Spain*
- *Case Study: Canada*

ABOUT THIS STUDY

- This presentation provides partial highlights from an occasional series of analyses that began to appear on Stratfor.com in December 2014.
- This study examines a few of the widely occurring contributors to water stress and water scarcity in various parts of the world, as well as selected case studies.
- More information about the series as a whole can be found at the end of this presentation.

INTRODUCING WATER

To borrow a phrase from Edwin Starr:

**“ Water!
What is it good
for? ”**

Absolutely everything!
I'll say it again ...



INTRODUCING WATER

***“ Water!
What is it good
for? ”***

Water is essential for:

- Manufacturing
- Agriculture
- Commerce
- Many types of energy
- Economies
- The existence of human and other life forms



WATER – PROS AND CONS

It can also be:

- Polluted
- Desalinated
- Recycled
- A force of life or destruction



WATER – PROS AND CONS

One thing water can never be:

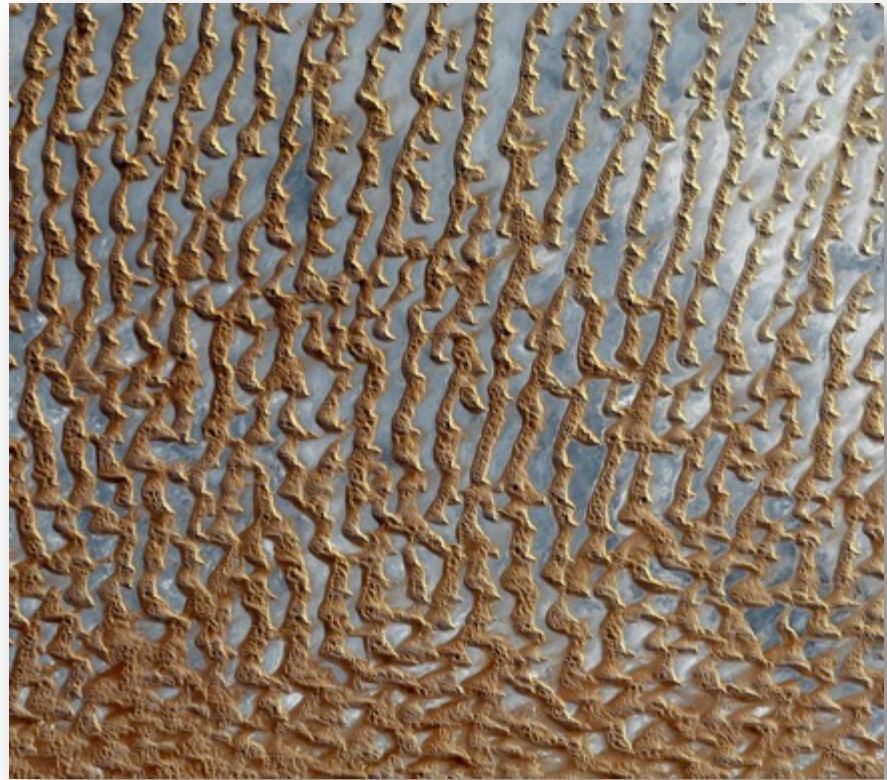
- **Manufactured.**

(Cloud seeding technology still has some distance to go.)



WATER AND GEOPOLITICS

Clearly, water – and more specifically, the issues of water stress and water scarcity – are key forces in geopolitics.



WATER AND GEOPOLITICS

When areas are under water stress, effects can include:

- Reduced food and livestock production
- Population movements
- Additional costs of living
- Famine/starvation
- Political stress
- Other problems



A Closer Look at Issues

ONE PIECE AT A TIME

Let's break this down a little more, by focusing on a few key concepts:

- Definition of terms
- Common issues affecting water availability
- Common effects of water stress or scarcity
- Case studies

DEFINITION OF TERMS

- **Groundwater resources:** Water found in underground aquifers.
- **Land subsidence:** The settling or sinking of land stemming from movement of underground material.
- **Water scarcity:** Less than 500 cubic meters of water per person per year (500 m³/capita/year).
- **Water stress:** Situations in which water availability poses a serious constraint on human activity. By some definitions, this amount equals less than 1,000 cubic meters per capita per year (1,000 m³/capita/year).

WATER AVAILABILITY: COMMON ISSUES

Many factors can influence the amount of fresh water available to communities and populations. These include, but are not limited to:

TERRAIN



CLIMATE



INFRASTRUCTURE



FARMING PRACTICES



GOVERNMENT



PUBLIC ATTITUDES



WATER AVAILABILITY: COMMON ISSUES

- **Geographic terrain** and **climate** are interrelated but separate issues:
 - **Terrain** refers to the topography of an area – with features such as mountains or rivers that can naturally supply or absorb freshwater supplies
 - **Climate** refers to factors like average temperatures and annual precipitation, which can shape not only flora and fauna, but also human culture within a region
- **Public infrastructure** – Does the area have strong infrastructure -- such as reservoirs, dams or aqueducts for storing and distributing water, or desalination plants to increase the amount of water available for consumption?

WATER AVAILABILITY: COMMON ISSUES

- **Strength of political institutions** – In countries with weak political institutions or warfare, water distribution or accessibility can be challenging issues. Where conflict exists, control of water sources is a strategic advantage.
- **Farming practices and water management techniques** – The types of crops grown for food or cash can drastically impact the amounts of water available for other uses. Whether irrigation or other techniques are used to raise crops, and how water is conserved or managed, also are key factors.
- **Public attitudes:** Does the populace of a region view water as a “common right” for the public? Or do commercial attitudes prevail, suggesting that water is more of a commodity that can be traded or sold for profit?

WATER AVAILABILITY: OTHER FACTORS

Other factors can also have short- and long-term impacts on water availability. These include:

- Population growth – high birth rates and/or migration levels
- Public health issues – pollution and disease epidemics, such as cholera, can also lead to problems with water availability and distribution
- Industrial growth – Oil and natural gas production, high technology manufacturing and other industries can be highly water-intensive

WATER SCARCITY: COMMON EFFECTS

The effects of water stress and water scarcity can be felt in many ways, both immediate and long-term:

REDUCED OUTPUTS



HIGHER COSTS



POLITICAL STRESS



MIGRATION



FAMINE



WATER SCARCITY: COMMON EFFECTS

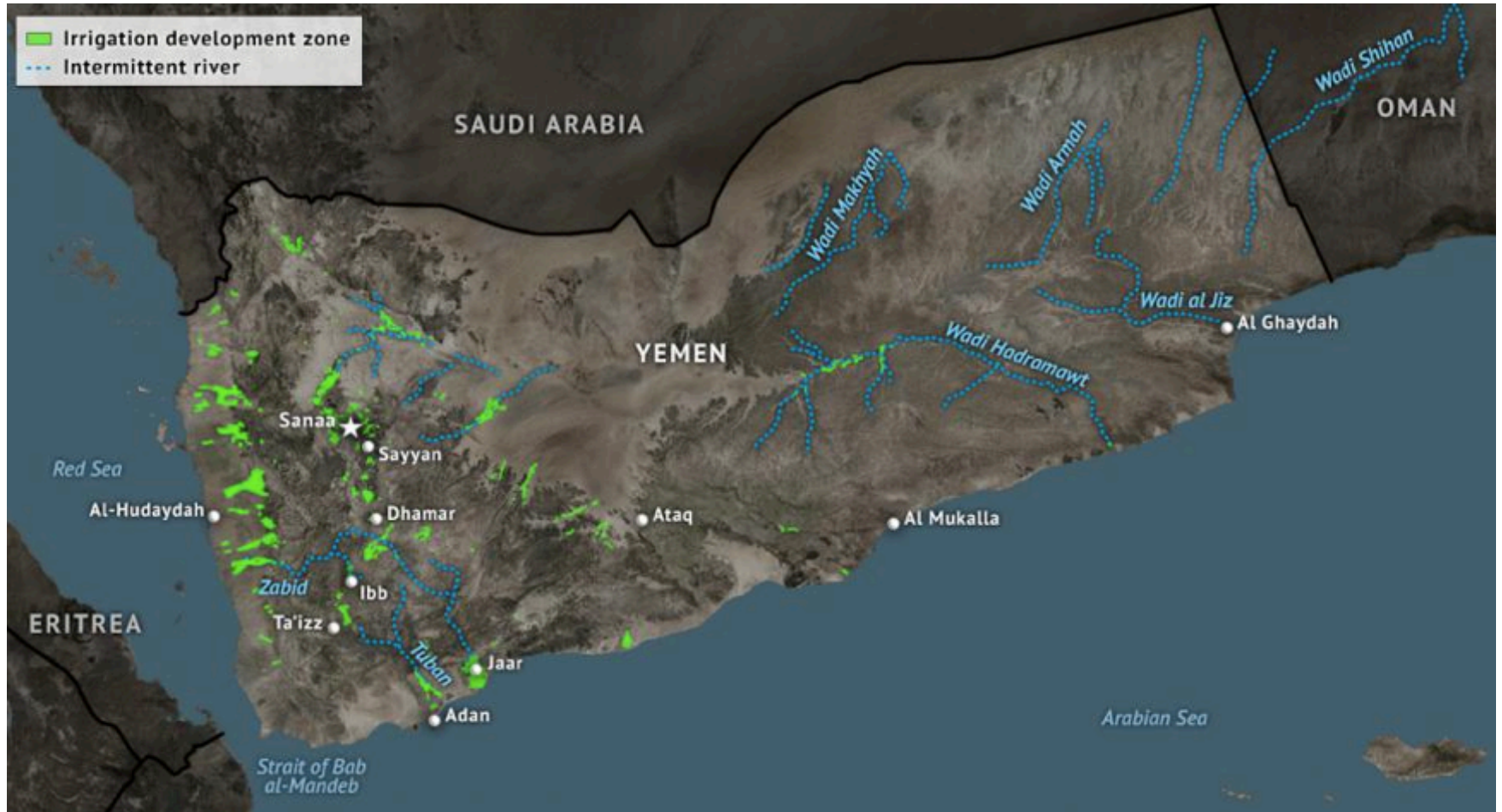
- In many cases, conditions leading to water stress and scarcity emerge slowly, and effects are felt incrementally
- Common Effects:
 - **Reduced production** of crops or livestock for market
 - **Higher costs** for goods and commodities, which can result from market shortages, increased need for imports or other logistical factors
 - **Political stresses** can become evident where consumers are impacted by shortages or economic pressures

WATER SCARCITY: COMMON EFFECTS

- Extreme Effects:
 - In prolonged droughts, **mass migrations** might be seen to areas where jobs or agriculture are more plentiful (*example: United States “Dust Bowl”*)
 - **Famine and starvation** are also potential outcomes in poverty-stricken areas or in cases of severe water scarcity

Yemen:
A Worst-Case Scenario

IRRIGATION IN YEMEN



YEMEN IN HISTORY

- Yemen – now one of the world’s poorest countries – was once a paragon of water engineering.
 - Advanced irrigation and water management techniques from times of antiquity
 - Great Dam of Marib – an engineering marvel of the ancient world
 - Water supply is entirely internal – no external dependencies
- Transition period in recent history:
 - 1970s: Agricultural expansion required more groundwater for irrigation
 - 1980s: Yemen became oil-producing country, leading to creation of cash economy
 - 1980s: With cash economy, demand for qat – a highly water-intensive narcotic grown in Middle East – shot upward

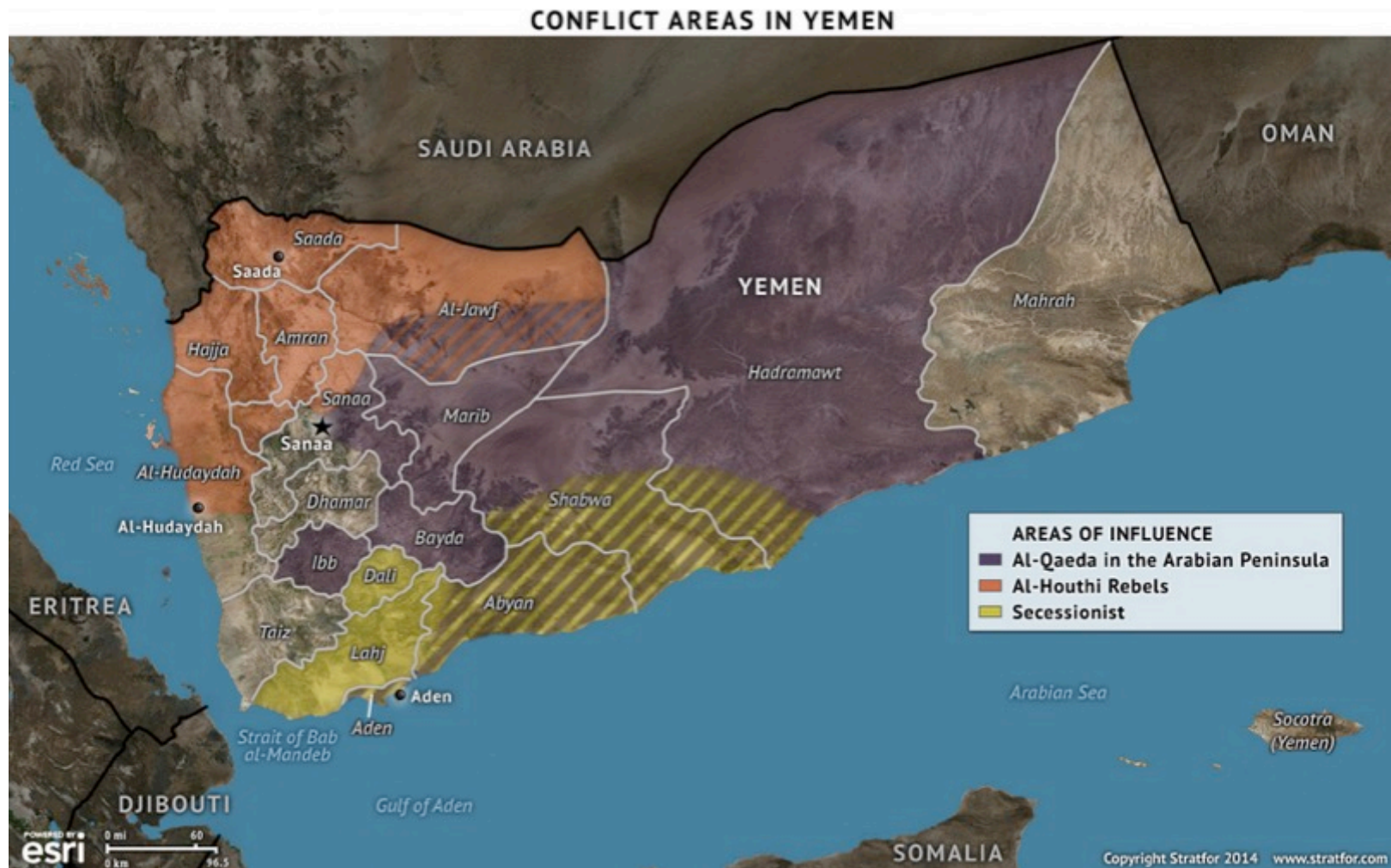
YEMEN BY THE NUMBERS

- **~2.1 billion m³** of renewable water resources per year available
- Groundwater: About 70% of Yemen's overall water supply
 - Groundwater recharged by irregular surface flows of wadis
 - Most important source of water
- Water deficit: Yemen withdraws **3.5 billion m³** in freshwater sources/year
 - Most aquifers overexploited
 - Saltwater intrusion and pollution in many areas

YEMEN TODAY

- Extreme water scarcity: Population lives on only 86 m³/capita/year
 - High annual population growth – from 3% in 2001 down to about 2.3% in 2014
 - Agriculture commands nearly 90% of all water withdrawals
 - Qat accounts for about 20% of all irrigated acres
 - By some estimates, qat takes up half of all agricultural withdrawals
- **Conclusion:** Large parts of the country could literally run out of water within the next decade if stay the current course

YEMEN'S CONFLICT AREAS



YEMEN'S SECTARIAN CONFLICT

- Yemen today is perhaps best known for the civil conflict raging within its borders.
 - Conflict is not the source of – but adds to – water stresses in the country.
 - Control of water resources is now a strategic asset for warring parties.
 - Political instability further strains country's ability to maintain existing water infrastructure or invest in new water sources.

OUTLOOK FOR YEMEN

- **Increasing strains on municipal water supplies** to support growing population
- Water supplies lost to **dilapidated infrastructure and inefficient irrigation**
- **Constraints on water supplies will hurt industrial growth** – particularly in energy sector
- **Economic impacts** of failure to address water management issues will become more evident
 - Estimated 1.5% of GDP lost to groundwater depletion
 - ~2.4% of GDP is lost due to poor water sanitation (*U.N. Development Program*)
- Outlook for **political stability**: Poor

POTENTIAL OPTIONS

Key solutions available for
Yemen:

THEORETICALLY
POSSIBLE?

WITHIN GOV/
ECON MEANS?

Update infrastructure



Control well drilling/management



Implement conservation policies



Invest in/implement desalination

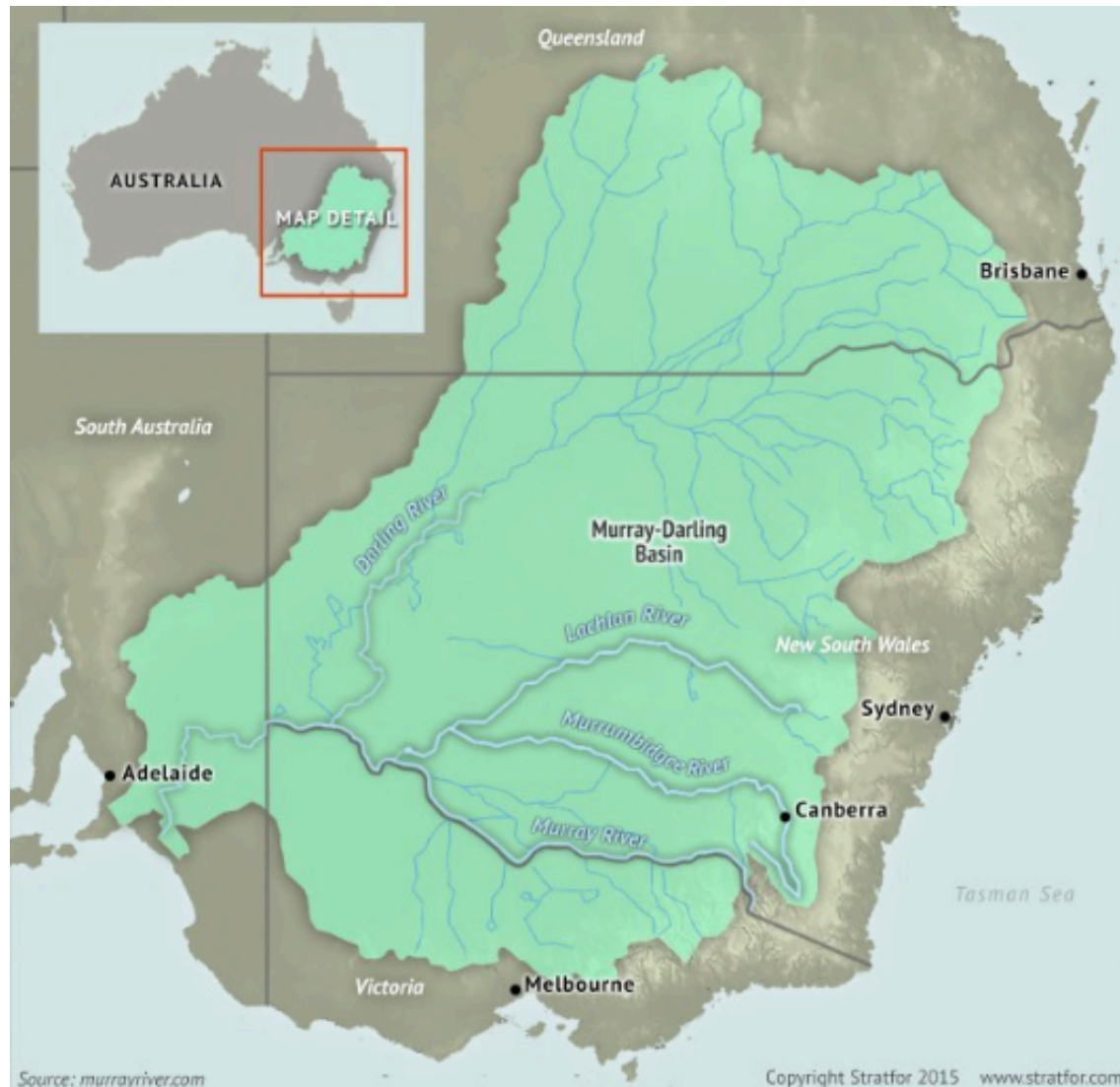


WHAT TO EXPECT

- **Dire outlook for Yemen:**
 - Onus for change falls to local governments – often corrupt, inefficient and poorly funded
 - Water withdrawals likely to exceed annual renewable inputs
 - Water scarcity contributing to unrest
- **Other countries to watch** (*withdrawals exceed annual renewable inputs*):
 - Jordan
 - Egypt
 - Parts of Palestinian Territories
- Prolonged instability would damage ability to implement water management strategies
- Near-term changes needed for long-term impact

Australia:
Virtual Water Exporter

MURRAY-DARLING BASIN



CHALLENGES AHEAD FOR AUSTRALIA

- Arid climate – already driest inhabited continent
- Domestic water consumption levels
- Crop exports – mainly to China
- Virtual water exporter
- Water intensive agriculture and trade goals

WORKING IN ITS FAVOR

- High water availability per capita
- Comparatively efficient water usage
- Strong water management policies
- Public awareness of water usage
- Low population reduces overall impact of domestic consumption

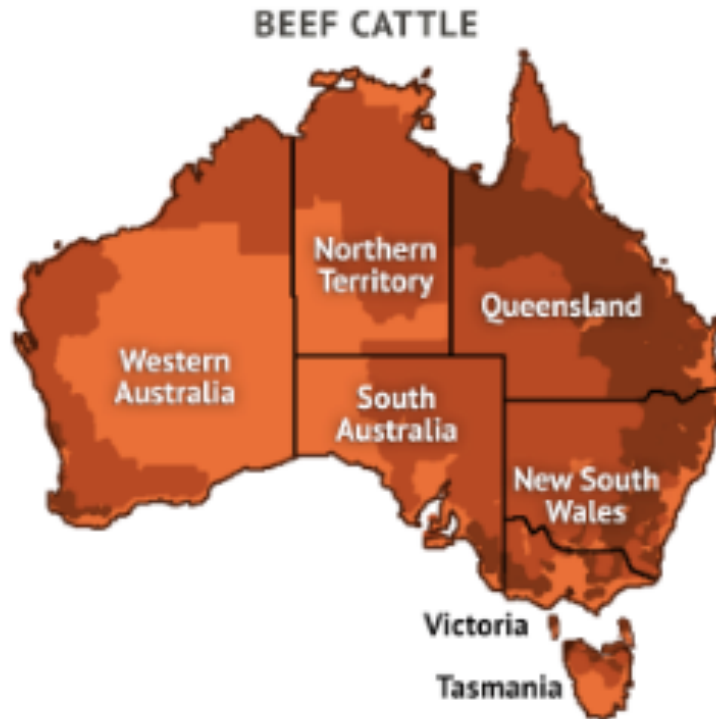
AUSTRALIA BY THE NUMBERS

- 21,077 m³/capita/year – relatively high, but not evenly distributed
- Overall consumption - roughly 1,200 m³/year
- Total withdrawals = ~23 billion m³/year
 - Agriculture - ~74% of the total
 - Uses more water as percentage of total use than other developed countries, although is comparatively efficient
 - Uzbekistan – 56 billion m³/year – 90% agriculture
 - Pakistan – 184 billion m³/year – 94% agriculture
- Areas with high agricultural output = greater water stress
- Murray-Darling Basin = >40% value of country's agricultural production

AUSTRALIAN AGRICULTURE

BEEF AND WHEAT PRODUCTION

Major agriculture areas account for approximately 75% of the total national production annually. Major and minor agriculture areas combined account for approximately 99% of the total national production annually. Figures are for 2010-2011.



Source: USDA

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AGRICULTURE IN FOCUS

- Murray-Darling Basin:
 - New South Wales+Victoria produce:
 - 48% of Australia's corn
 - 31% beef
 - 43% wheat
 - 75% dairy cattle productions
 - Water resources highly stressed:
 - Groundwater strains showed mid-1990s
 - Severe drought, 2001-2007
 - Environmental degradation of rivers
 - 1/3 of rivers substantially modified

CORRECTIONS THROUGH POLICY

- **National Water Initiative** – blueprint for water reform, over 10 years old
 - Cooperative management system
 - Goal: Correct inefficient, sometimes unregulated overuse of groundwater and surface water – resulting in economic, efficient and sustainable water practices for entire country
 - Address over-allocation of stressed systems
 - Improve water pricing
 - Responsibilities rest with each state/territory
 - Emphasis on accurate data
- Trading rules within Murray-Darling Basin:
 - Irrigators can buy and sell water allocations and entitlements as needed to level distribution
 - July 2014 – Inter-state water trading rules implemented (encouraging efficient usage)
 - Staple crops might suffer

CHINA'S FARM TEAM SYSTEM

- China is destination for ~1/3 of Australia's food exports
 - Growing relationship: FTA terms agreed November 2014, "Most Favored Nation" trade status secured March 2015
 - Geographic proximity makes Australia key food supplier
 - Removal of beef and dairy tariffs gives Australia additional advantages

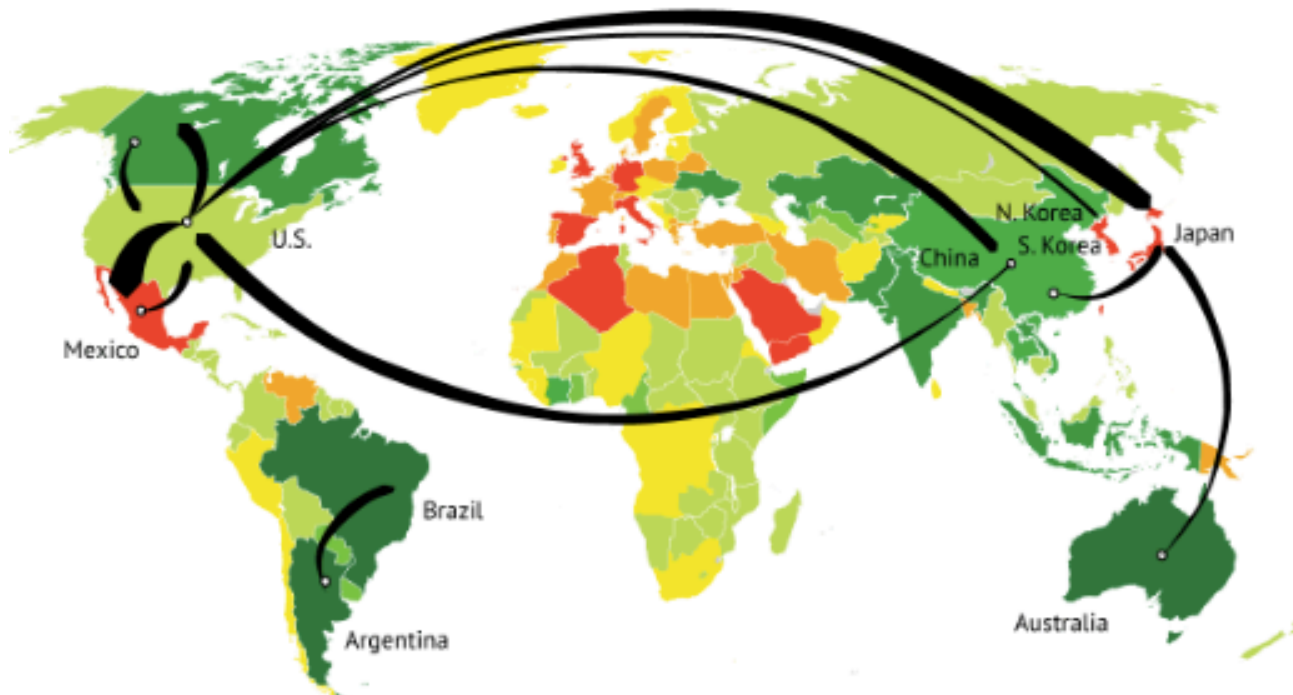
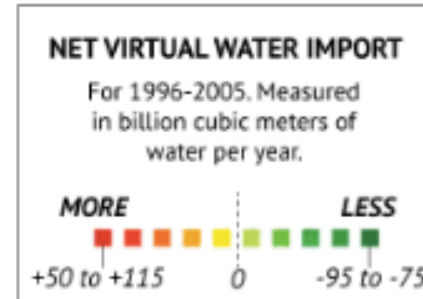
CHINA'S FARM TEAM SYSTEM

- China invests heavily in food security strategies:
 - Land ownership abroad
 - Northern Territory, Queensland – highest percentages and volumes of foreign-owned land in Australia
 - Mostly not dependent on Murray-Darling Basin
 - Focus of Chinese investments in Australia:
 - Beef and veal
 - Sugar mills
 - Seed companies
 - Grocery distributors
- **Australia is “virtual water exporter” due to significance of food/crop exports**

THE 'VIRTUAL WATER' CONCEPT

VIRTUAL WATER BALANCE

The exports and imports of food and commodities that use water in their production affect the virtual water balance of the countries involved. Water balance can be thought of as "net virtual water import," which is measured in billion cubic meters of water per year. Countries that have negative values (green) are virtual water exporters, while countries with a positive value (red) are virtual water importers. Australia and the United States, for instance, as large agricultural producers, are virtual water exporters, while Japan and many Middle Eastern countries are virtual water importers. The arrows on the map represent the largest (more than 15 billion cubic meters per year) "flow" of the virtual water, with larger arrows representing higher volumes.



WHAT TO EXPECT

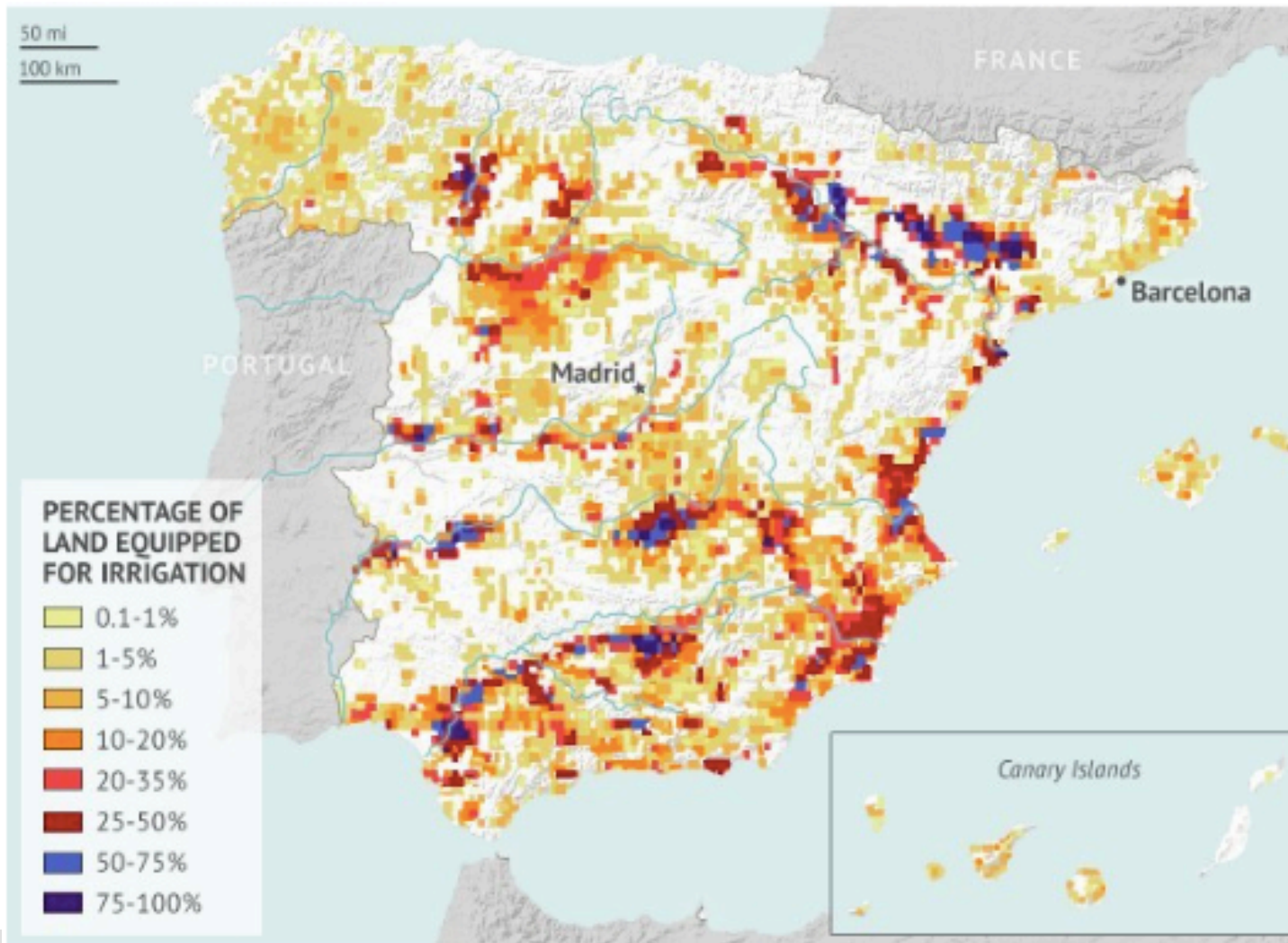
- **Australia will face consistent challenges in coming years:**
 - Drought conditions more prevalent
 - Reduced water resources to supply domestic population
 - Growth of food exports = virtual water exports
- **Continued focus on water management policies vital for Australia**

Spain:
A Study in Desalination

THE RAIN IN SPAIN

- ...makes it one of Europe's driest countries, on the whole
- 20th century - Limited water resources encouraged infrastructure development
 - Hydropower for electricity (some resources shared with Portugal)
 - Irrigation for agriculture
 - 1,300 dams – world's highest percentage of reservoirs per million people
- Snapshot today:
 - Agriculture = 64% all freshwater withdrawals
 - Irrigation key to farming sector
 - Irrigated acres produce disproportionate yields to total agricultural output – and ratio likely continue to grow

IRRIGATION IN SPAIN



SPAIN UNDER STRESS

- Hotter, drier climate expected in coming years
- Water exploitation index = “moderate stress”
 - **20% on index = stress**
 - **40% = severe stress, conditions not sustainable**
 - **34% = Spain’s index reading**
- Severe stress in some regions:
 - Andalusia – 164% withdrawals over replenish rate
 - Segura – 127% withdrawals over replenish rate
 - Declining groundwater levels in southern Guadiana Basin
 - Saltwater intrusion = poorer quality aquifer water in some coastal areas
- **Net result: Additional strain on remaining resources, or find alternatives**

ALTERNATIVE OPTIONS

THEORETICALLY
POSSIBLE?

POLITICAL OR
FINANCIALLY
FEASIBLE?

Potential solutions available for
Spain:

Update/expand infrastructure



Water conservation strategies



Invest in global desalination



WHAT DOESN'T WORK

- **Investment in water infrastructure:**
 - Needed to prevent water loss from leaks
 - Moderate losses (~16% for Spain as a whole)
 - More severe in some regions (20-25% loss in Cantabria, Extremadura and Castilla-La Mancha)
 - Infrastructure investment strong prior to 2008 financial crisis
 - Spain hard-hit by crisis, significant drop in public spending
 - Infrastructure investments out for next several years

WATER CONSERVATION STRATEGIES

- **Goal:** Encourage sustainable use in stressed and other areas
- **Tactic:** Raise prices to encourage use reductions
 - Current prices for some irrigators don't cover cost of transporting water to crops, let alone address amounts used
 - Public attitudes swing against private ownership of water infrastructure
 - EU Water Framework – “not a commodity like any other”
 - A “common good” or “heritage” to be protected and defended
- **Conclusion: Privatization/substantial price increases unlikely**
 - Political backlash possible

THE PROMISE OF DESALINATION

- Desalination holds promise for many countries that are or will be faced with water scarcity issues
- Significant promise to supplement existing sources of fresh water in urban coastal areas
- Spain home to many world leaders in desalination technology
 - ~700 desalination plants
 - Daily production sufficient for 8 million people
 - Spanish companies = largest % of competitors in global desalination market
 - Research
 - Design/engineering
 - Construction and plant operation
 - More than 50 members of Spanish Desalination and Reutilization Association

OUTLOOK FOR SPAIN

- **Global demand for desalination** will yield market opportunities for Spanish companies in regions around the world, including the Middle East and California

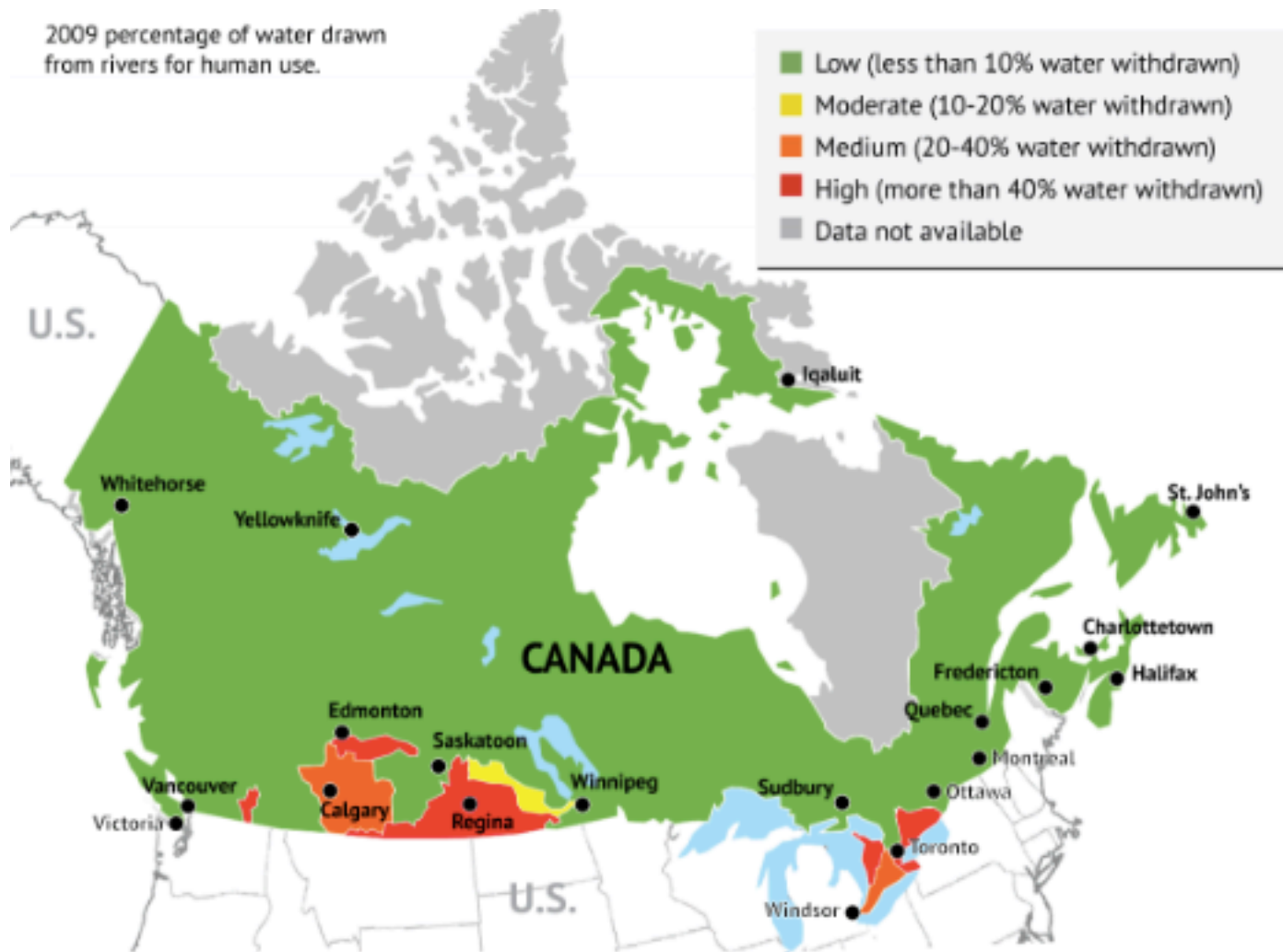
Canada:

‘...Nor any drop to sell’

EVEN THE RICH HAVE PROBLEMS

- Canada is “water-rich” – at least on paper:
 - Home to ~7% of world’s renewable freshwater resources
 - <1% of world’s population
 - **80,000 M3/capita/year** – much more than other countries not considered “water stressed”
 - United Kingdom – slightly over 2,300 M3/capita/year
 - United States – a bit over 9,500 M3/capita/year
- What’s the problem with “wealth on paper”?
 - Low water prices (among lowest in OECD) encourage over-use
 - Unequal distribution:
 - Majority of population in south
 - 60% of rivers drain to the north
 - Some areas experiencing a degree of water stress as a result

THREATS TO AVAILABILITY



STRESSORS IN FOCUS

- Prairie provinces: Alberta, Manitoba, Saskatchewan
 - More arid than most others
 - Expanding agricultural, industrial production
 - Growing population in recent decades
 - Some areas under higher water stress than others, expected to increase in coming decades
- Changing climate:
 - River headwaters fed by glaciers
 - Glaciers shrank by ~25% in last century
 - Forecast: Higher temperatures, more frequent droughts

THE BIG PICTURE

- Although pressures on water supplies are growing in some areas, Canada's stresses are dwarfed by those in other regions:
 - California
 - United States' Ogallala Aquifer
 - Colorado River Basin
 - Middle East
 - South Asia
 - Etc.

SO WHY NOT SHARE?

- “Water export” schemes for U.S. markets have come up perennially for more than 50 years
- Technical challenges:
 - Water is heavy
 - Energy-intensive pumping required to move it through changing elevations
 - Long-distance transfer costs can be more than 5x cost of local desalination or recycling
- Market challenges
 - Water prices don’t usually reflect typical supply-demand dynamics
 - Limited profit potential = limited investor potentials

PROPOSALS FROM HISTORY

- North American Water and Power Alliance – most extensive transfer project proposed
 - Dates from 1950s
 - Use existing waterways and a series of new canals, pumps, reservoirs and other elements to redistribute water in North America
 - Never gained much traction
- Great Recycling and Northern Development Canal of North America
 - Also dates from mid-century
 - Would reroute freshwater runoff from James Bay south to Great Lakes
 - Projected cost: \$100 billion (1960) – more than \$800 billion (today) to build
 - \$1 billion/year to operate

CHECK THE ATTITUDE

- Political attitudes likely to prevent Canada from trading water in the same way as oil or natural gas:
 - Even if economically viable
 - Despite its friendship with United States
- Aversion to market-based conservation techniques
 - Would market pricing of Canadian water open door to legal action from NAFTA partners?
 - Desire to protect water resources in era of growing scarcity

THE POLICY DEBATE

- Is water a tradable good?
 - Protectionist sentiment strong within Canada
 - “Public right” vs. “commercial good” perceptions prevail

THE POLICY DEBATE

- Federal policy typical against large-scale water transfers
 - Free trade agreements – 1980s and early 1990s – ignited debates
 - British Columbia water export plans failed to materialize in face of public resistance
 - 1999 – Federal government proposed voluntary accord to ban withdrawal and transfer of water in quantities that could damage environment
 - Great Lakes-St. Lawrence River Basin Water Resources Compact, 2005
 - Cooperative management of water resources between 8 U.S. states, 2 Canadian provinces bordering Great Lakes
 - Limited most bulk water transfers

CONCLUSIONS

- Geography will constrain access to useable freshwater resources for many countries in future
- Exports from water-rich to water-stressed regions will not follow same path as energy exports
 - Economic constraints
 - Public attitude constraints
- Water viewed as more of a right than a good
 - Even countries with water abundance will seek to protect their resources in coming years and decades

IMAGE CREDITS

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 - Arsenie Coseac, “Food and non-food items at waystation,” Slide 15
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 - Slide 15 - “Okie migration car, Dust Bowl era” and “Children affected by famine in Berdyansk, Ukraine,” 1922

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