Three Scenes and Speculations from a Future City

If all design can be seen as ways to predict—and shape—the future, no field ought to look further forward than urban design and planning. However, as a profession, planners tend to be fairly cautious, relying on historical precedents rather than future trends in shaping cities. There are perfectly rational reasons for this tendency; the past is a more knowable territory than the future. And yet, do we limit our vision if we fail to occasionally untether ourselves from the past, and seek where design opportunities may lie in the future?

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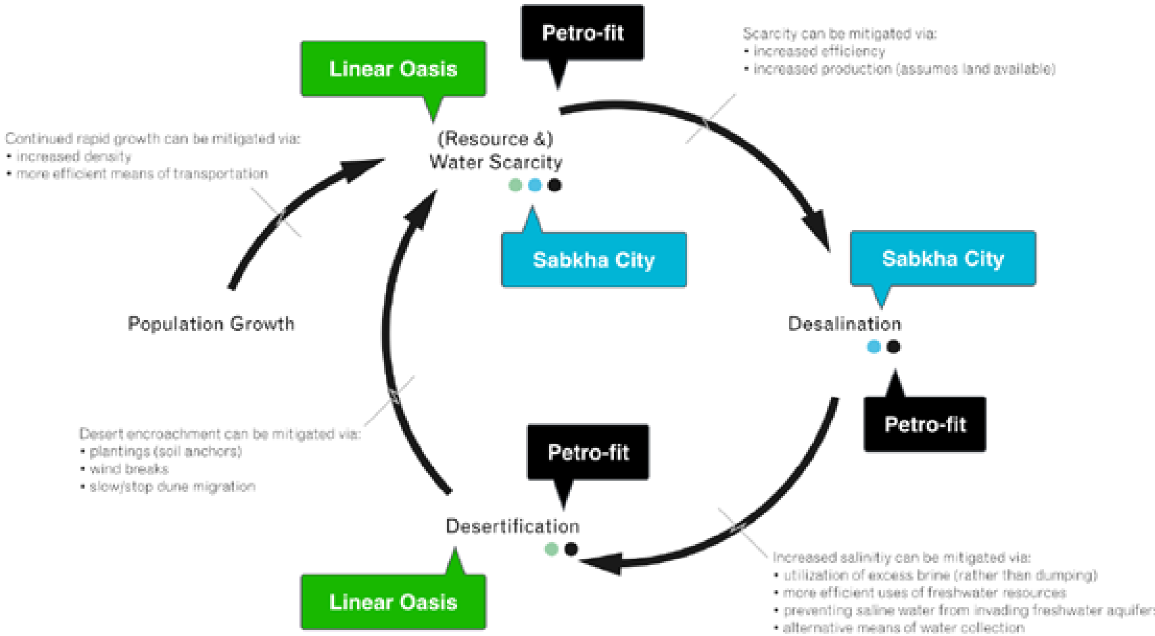
INTRODUCTION

Our research team—architects and urban designers, curious about alternative approaches to designing the urban future, especially as they relate to the Middle East—began by creating a digital compendium of all the predictions we could find (past and present) related to the future of urban environments. We tagged and sorted these in various ways to see what we might uncover. Among the most interesting (and obvious) discoveries was the observation that projections into the future are more telling of the present in which they are created. For example, many of the anxieties of the 1980s revolved around a potential nuclear armageddon. Today, it's ecological disaster that terrifies us.

We then focussed our lens on urbanization in the rapidly developing world, specifically exploring the design possibilities in a future desert conurbation, one perhaps very similar to Doha, Qatar and its environs. Doha intrigues us for a number of reasons. While unique in many ways (high standards and ambitions, the world's highest GDP per capita, highest carbon footprint per capita, and a overwhelmingly expatriate population), in many ways the rapid population growth and frenetic urban/suburban development here can be seen as harbingers of things to come elsewhere. The number of people living in Qatar has trebled in the past 17 years, and four fifths of them live in the greater Doha area, which has quadrupled in size during that same time, growing not only up, but out as well.[1] Inevitably, this growth has put a great strain on the fragile desert and marine ecosystems upon which the city sits.[2]

We examined three distinct situations in greater detail, and offered design proposals for three potential future scenarios: the Linear Oasis, a hybrid vegetative and mechanized wall designed to address issues of desertification and urban sprawl; Sabkha City, a possible response to rising sea levels and issues of



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desalination; and Petro-fit, a regionally-scaled investigation of possible uses for the infrastructures of oil and gas following the industry's demise.

The relationship between some of Doha's most challenging issues is illustrated above. The city's rapidly increasing population exacerbates a feedback loop of increasing water scarcity, desalination, and desertification. Each of the three projects below proposes a potential integrated solution to some or all of these issues for a future Doha.

SCENE ONE: DESERTIFICATION

Desertification threatens over one-third of the Earth's population and affects over 40% of its land area. Over twelve million hectares of arable land is lost every year to desert encroachment. Despite this consistent loss of land, the UN projects that to support a predicted population of nine billion people in 2050, a 70% increase in food production is required.[3]

A windswept desert peninsula, Qatar's geography and climate have forced it to import 90% of its food.[4] Its meteoric population growth has all but exhausted what scarce groundwater reserves it had.

Overexploitation of underground reservoirs has caused seawater to creep in, contaminating the water table and hastening the demise of agricultural productivity. Because of this, one-fifth of small farms stand abandoned throughout the country.[5] In the last twelve years, Qatar's water reserves have been reduced by 25%,[6] but its food needs are projected to increase by 6.3% between 2011 and 2015 alone.[7] Qatar's increased population, sprawling urban settlements, and consumption habits only add to the strain on already limited resources.

Without the plant life sustained by small farms and the natural desert vegetation, soil is no longer anchored in place and is blown away, leaving nothing to stem the desert's advance. Overgrazing by camels exacerbates the situation by eliminating plant life in uninhabited areas as well as those settled by people.[8] Desertification

Figure 1: The three speculations as they relate to Doha's main challenges. for the future.

increases the risk and severity of sandstorms due to the decreased number of obstacles in a storm's path.

Coupled with Doha's sprawling urban growth pattern, a rapidly expanding population will be exposed to stronger and more frequent storms. The increased number of people and the inefficiency of their settlement may well overtax Qatar's dwindling water and food resources.

SPECULATION ONE: LINEAR OASIS

The Linear Oasis is a hybrid botanical-mechanical infrastructure that provides integrated solutions to the problems of desertification, resource scarcity, and urban sprawl at a regional scale. It simultaneously serves as a barrier to sandstorms, a self-sustaining source of water and food, and a limit to urban growth. After the construction of its most basic infrastructure, the Linear Oasis can passively collect water from the atmosphere, subsequently supporting local agriculture, live-work settlement, and transit infrastructure.

Due to the confluence of climatic, resource, and urban challenges presented in Qatar, it will serve as an excellent case study for the deployment of the Linear Oasis. However, it should be noted that the strategies presented here may be adapted to fit the specific challenges and assets of other inhabited desert areas.

The Linear Oasis is reminiscent of fractal geometry, using similar forms at multiple scales for a variety of effects. Operating at its largest scale, it is a wall spanning the breadth of Qatar, built perpendicular to the prevailing winds to shield the majority of Qatar's population from sandstorms. However, these northerly winds are also one of Qatar's greatest climatic assets; thus, the wall must be porous enough to admit cool breezes, but solid enough to break the momentum of sandstorms bearing down on the urban east.

These winds present another opportunity: due to Qatar's peninsular condition, breezes blow inland from the Gulf, carrying moisture with them. By intelligently shaping and nanotexturing the smallest components of the Linear Oasis system, this moisture can be collected from moving air.[9] A surface of alternating hydrophobic and hydrophilic areas pulls moisture from the air at the nanoscopic level. This texture is echoed at the scale of a single building component, which when aggregated together form a surface of triangular facets oriented towards prevailing winds to optimize the water collection capabilities of the nanotexture. The orientation of the components is echoed in each of the building units that comprise the nationwide wall.

These units take the form of inverted triangular pyramids. The prow of each faces due north, presenting a long face to prevailing winds in the north-northwest and a shorter face to summer winds in the northeast. The orientation of each face serves to redirect the winds without diffusing them. The inversion of the pyramid presents a larger surface area of water-collecting components into stronger winds at high elevations, while weaker winds nearer to ground level are allowed to blow through the wall towards settlements.

Most water collected from wall components flows down the face of each pyramid towards a central water tank integrated into the base of each unit, though some is redirected to plants integrated into the façade to clean dust from the air as winds blow across the surface. The water tank feeds into a drip irrigation system that supports small-scale agriculture along the southern face of the wall. These plots are tended by live-in farmers who reside in modular housing units installed in the space

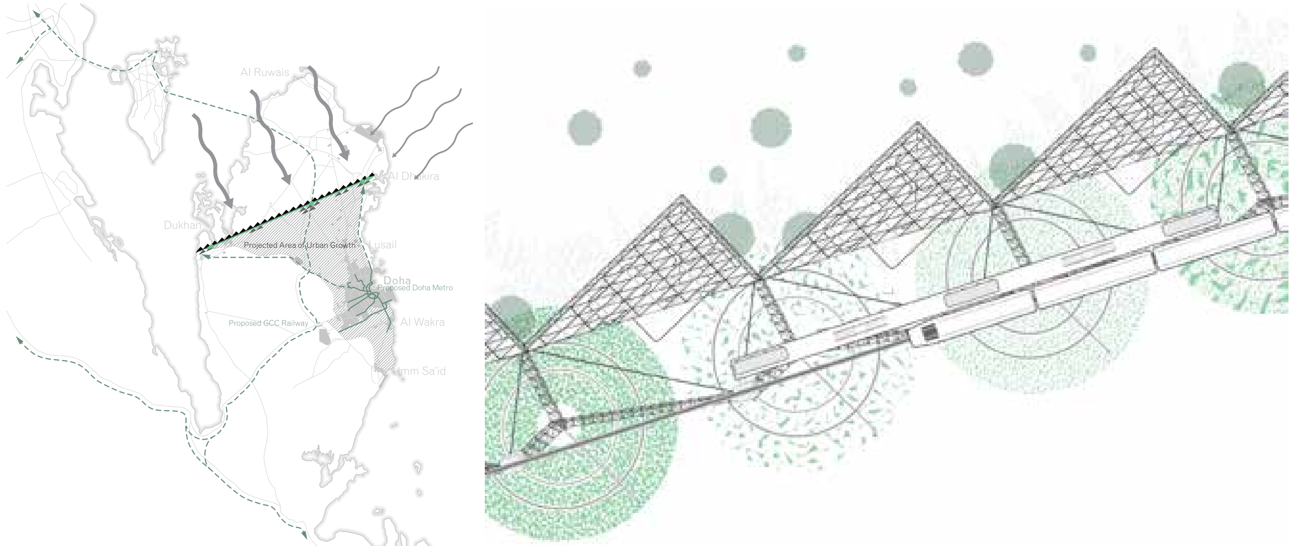

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Figure 2: Views of the green infrastructural line at two different scales.

frame structure on the southern face of the pyramid units. If a pyramid unit does not support agriculture, the water it collects could service other settlements.

Residents of the Linear Oasis are linked to each other, and their produce to urban centers, via a light rail transit line that runs along the top of the wall from the town of al Khor in the east to Dukhan in the west. Stations could be placed along the wall to spur future growth away from existing urban areas. The wall could even expand to the south to support more agriculture, a more intense form of settlement, or to respond to the wall meeting an existing urban center. Transit along the Linear Oasis has the potential to tie into the proposed Doha Metro and GCC Rail systems. The integration of these transit lines suggests a third line between Education City and Dukhan that would in turn delineate an ideal area for future urban growth that is well-serviced by transit, protected from sandstorms, and securely supplied with food and water.

SCENE TWO: RISING WATER

Continuing global climate change is expected to result in both increased temperature and sea level, the effects of which will be magnified in the world's most heavily populated urban centers. Almost half of the global population lives within 100 kilometers (62 miles) of a coast, including 23 cities with populations over 5 million.[10, 11] Rising seawater not only threatens cities with inundation, but can also contaminate underground freshwater aquifers. In the Middle East, and the Gulf especially, sea level rise becomes a particularly acute problem as temperatures in the region are projected to rise by as much as 6°C by 2100 and water scarcity is already a growing concern due to ballooning populations.[12] Should sea level rise by even one meter, 41,500 km2 of coastal land in GCC countries will be adversely affected.[13] Forecasts of an increase of one meter are all but considered baseline; some experts predict upwards of two meters by the century's end.[14]

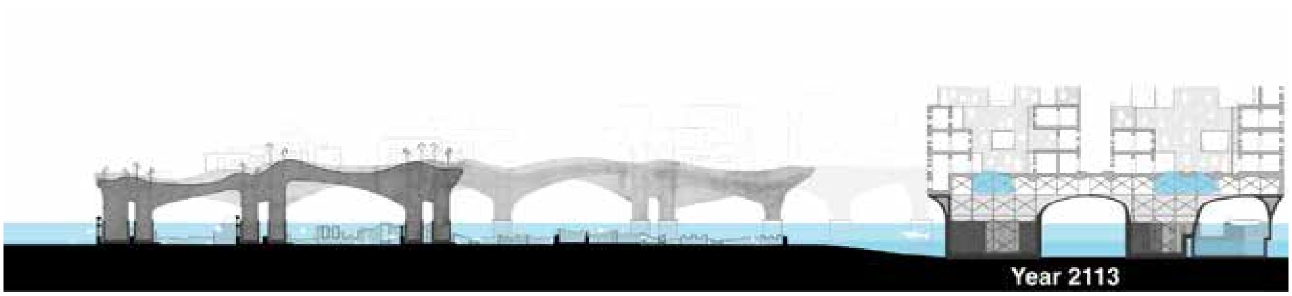
At the same time, desalination is a reality of the region, with just under half of the world's plants located on the perimeter of the Gulf. Separating the salt from the water provides a valuable source of potable water that has allowed these desert cities to thrive, but the process has two major drawbacks: first, it is energy intensive, and second, the brine that is dumped back into the Gulf threatens the fragile marine environment.[15]

SPECULATION TWO: SABKHA CITY

sabkha [ˈsæbkə] n. (Geography) an area of coastal flats subject to periodic flooding and evaporation, which result in the accumulation of aeolian clays, evaporites, and salts, typically found in North Africa and Arabia [16]

Sabkha City is a phased urban strategy to adapt an existing coastal settlement for use after rising sea levels have made its continued habitation untenable. Rather than attempt to stem or to mitigate the effects of littoral encroachment, it accepts the impending inundation of the area and subverts the destructive potential of seawater into the driving force enabling future habitation. As sea levels rise, the Sabkha City grows larger; tidal surges generate freshwater and building material. By century's end, the city becomes an elevated oasis of land surrounded by water.

Due to its low-lying coastal location on the increasingly saline Gulf,[17] as well as the growing pressure placed on its limited freshwater resources, al Wakra, Qatar will serve as a case study for the application of the Sabkha City strategy. Focusing specifically on al Wakra's historical village—an area of cultural significance to the country—demonstrates how this strategy could address a desire to preserve portions of an otherwise inundated original settlement.



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Initially, Sabkha City is a skeletal framework of scaffolding, mesh, pulleys, and raised walkways linking the most important sites within the historical village. Villas in the flood plain are selectively sacrificed, becoming solar stills or storage tanks within a larger, tidally operated, passive-solar desalination system. In addition to providing a constant supply of potable water for inhabitants' consumption, the system disperses the excess brine over the mesh and scaffold framework, where the saline mist evaporates into a crust of salt, thickening over time into an elevated plain. The city's skeleton deteriorates beneath its saline coating, leaving behind a fused carapace of salt columns and an irregular network of vaults. Over time, new living spaces can be built on or carved from the synthetic landscape to replace those that will inevitably flood below.

Parallel to the construction of this framework, buildings of particular significance are preserved in chambers made of concrete poured directly over their surrounding context. Apertures in the concrete admit views into the village beyond as it floods. As sea levels rise, these sites become the nodes linking the deteriorating residential areas below with the new ones above. The village is further interconnected by tidally operated bridges and stairs that allow people to explore its flooded areas.

In anticipation of their eventual inundation, the courtyards of remaining villas are lined with concrete. As sea levels rise and al Wakra deteriorates, these casts become buoyant and drift free. Salt plugs in the concrete dissolve as they float out to sea, though the prevailing winds keep them close to shore. The city framework springs anew from these footers; the sabkha expands, flecked with reservoirs of desalinated seawater. Plazas form around the freshwater founts and

Figure 3: A new elevated ground plane is formed by making use of the unwanted by-product of the desalination process.

new housing blocks grow out of the landscape to be excavated and inhabited. The haphazard placement of the footers creates a variety of private courtyards between buildings and necessitates an irregular network of pedestrian pathways through the city reminiscent of the original historical village.

SCENE THREE: THE END OF OIL

Sometime around the year 2100, all oil and natural gas in the Middle East will be depleted.[18] Miles of pipeline, scores of massive storage tanks, refineries the size of cities, and the 120 offshore oil and natural gas rigs that ply the Gulf today will all be abandoned. The sheer scale of this "leftover" infrastructure is difficult to comprehend. The offshore platforms alone span almost 450,000 m2 and could stretch 7.6 km if placed end to end. Each liquid natural gas (LNG) storage tank at Ras Laffan Industrial City, Qatar has a capacity of 140,000 m3, measuring 78 meters in diameter and almost 40 meters high.[19] Ras Laffan itself covers 295 km2; the municipality of Doha covers 132 km2. The issue at hand is simple: what might be done with this infrastructure?

SPECULATION THREE: PETRO-FIT

The size and quantity of these elements create opportunities at a variety of scales through a program of creative adaptive reuse of this soon-to-be-defunct infrastructure. The offshore rigs, which are designed for relocation, offer particularly exciting potential for recombination.

At the regional level, the rigs could be strung together to fashion piers for a new mega-causeway that capitalized on existing and planned links in the Gulf. From Basra to Musandam, much of the Arab edge of the body of water is currently populated and urbanized; strategic use of this infrastructure would cement the linear megalopolis that is already underway.[20] A more ambitious iteration would link both the northern and southern sides of the Gulf, allowing for free movement of people and goods between the waterfront cities in the Arab peninsula and Iran.

At the urban level, Qatar might consider constructing a new Doha Bay, or completing the current crescent shape to form a circular means for pedestrian and

Figure 4: A future Arabian megalopolis along the southern edge of the Persian Gulf?

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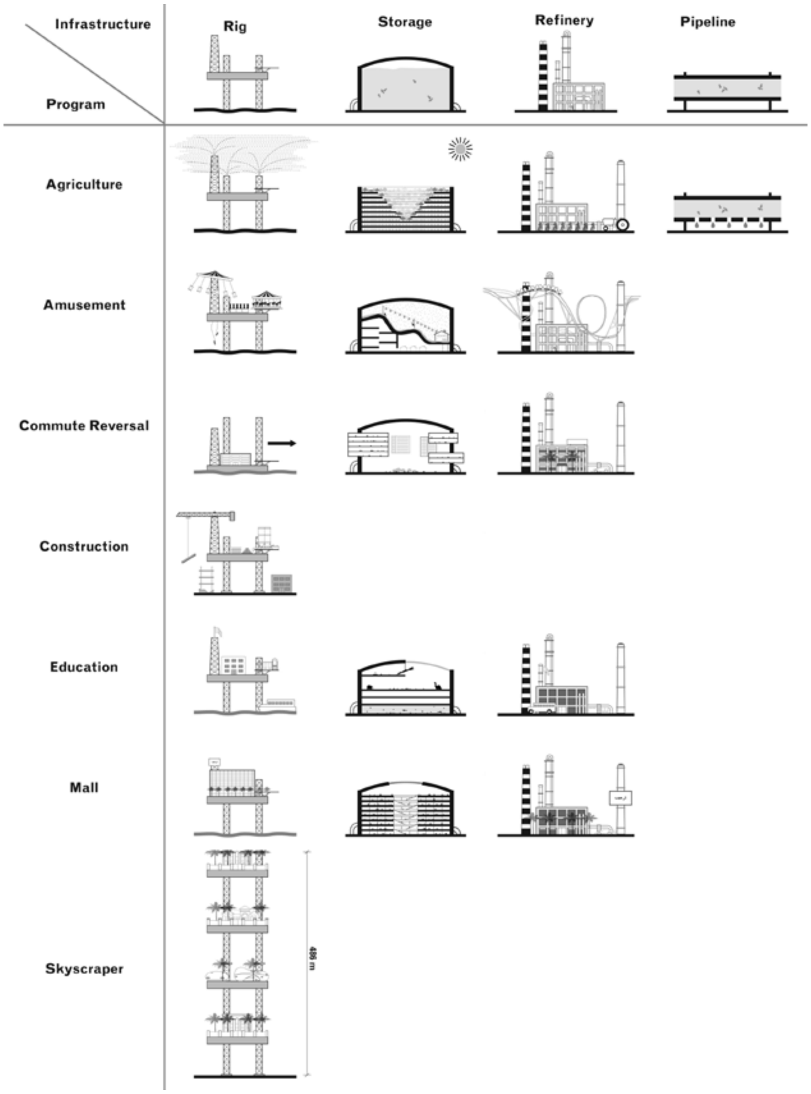

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vehicular perambulation. The rigs offer a number of potential retrofits, dependent on the national priorities: agriculture, amusement, education, retail super malls, live-work office parks.

Of particular interest is the residential rig-tower, which would make it among the tallest buildings in the region, if not the world. Unlike the typical tower, this one would allow for a series of interventions at each level, including unrealized or relocated projects for the city. In these ways, the infrastructure might be repurposed to allow for a variety of possibilities, depending on the needs and priorities.

CONCLUSION

Why offer such seemingly bleak and irreverent visions of the future for a region that is currently enjoying its moment in the sun? Development for the past decade has outpaced all expectations, and laudable investments in culture, sports and health are materializing at a surprising rate. For cities like Doha and it citizens, things have never looked better. While seemingly far-fetched scenarios, each of the options represents distinct possibilities should conditions continue along current trajectories. These speculations are intended to provoke thought, and to question the current *modus operandi*. In the end, what is needed

Figure 5: Options for adaptive reuse of a defunct infrastructure.

ENDNOTES

1. Qatar National Census 2010. See also author's research at www.4dDoha.com.
2. Renee Richer, *Conservation in Qatar: Impacts of Increasing Industrialization* Georgetown University Center for International and Regional Studies, 2008. http://www12.georgetown.edu/sfs/qatar/cirs/ReneeRicherCIRSOccasionalPaper20082009.pdf.
3. Environment News Service, "UN Leaders Focus on Preventing the Spread of Deserts | Environment News Service," *Environment News Service*, http://ens-newswire.com/2011/09/21/un-leaders-focus-on-preventing-the-spread-of-deserts/ (accessed 31 Jan. 2012).
4. Arwa Aburawa, "Qatar to Invest in 1,4000 New Farms," *Green Prophet*, http://www.greenprophet.com/2011/08/qatar-14000-new-local-farms/ (accessed 31 Jan. 2012).
5. The Peninsula Qatar, "Farmers Abandon Land Due to Water Salinity," *The Peninsula Qatar*, http://www.thepeninsulaqatar.com/ Display_news.asp?section=Local_News&subsection=Qatar+News&month=July2008&file=Local_News2008072522236.xml (accessed 31 Jan. 2012).
6. *Ibid*. Information is paraphrased from an unspecified document published by the Qatar Science & Technology Park (QSTP).
7. The Peninsula Qatar, "Food Consumption Projected to Grow by 6.3pc," *The Peninsula Qatar*, http://www.thepeninsulaqatar.com/qatar/157360-food-consumption-projected-to-grow-by-63pc.html (accessed 31 Jan. 2012).

is enlightened clients (and general public), who approach future growth with a long view rather than the typical developer-driven cycle that demands a return-on-investment within 18 to 36 months.

One glaring omission in our speculations on Doha involves the role its future inhabitants might play in its development. This remains among the most pressing questions for the city's future. Today, the situation is such that nationals comprise about six percent of the overall workforce.[21] Will it continue to be a city in which only a small minority are truly inhabitants, the rest transitory blue and white collar laborers, will it become a city with a Qatari majority, or will it become a city of global citizens, where all who work for it are made to feel that they belong?

8. Arvind Nair, "Camel Farms Proposed to Fight Desertification," *Gulf Times*, http://www.gulf-times.com/site/topics/article.asp? cu_no=2&item_no=173486&version=1&template_id=36&parent_id=16 (accessed 31 Jan. 2012).

9. This type of surface is naturally occurring in the shell of the Namib Desert beetle. Scientists at the Massachusetts Institute of Technology have developed materials and appliqués that mimic the properties of the beetle's shell, though at this writing, they have not yet entered the public market.

10. Estimates vary widely on this statistic, ranging from as low as 23% (Greenpeace) to as high as 60% (Global Environment Facility). Almost all sources define "the coast" as the near coastal zone, an area within 100 meters (328 feet) in elevation and 100 kilometers (62 miles) of the coast. Whether the coast is defined solely as an area adjacent to a sea or the ocean or if it includes river coastlines is unclear and may account for the statistical variability. Though a consensus is difficult to determine, between 40–50% seems the most plausible.

11. "Sea Level Rise | Greenpeace International." Greenpeace | Greenpeace. http://www.greenpeace.org/international/en/campaigns/climate-change/ impacts/sea_level_rise/?accept=183de9769c809dbff492c7cf057afbcf (accessed January 30, 2013). Twelve of these cities have populations over 10 million.

12. Reed Landburg, "Climate Disasters Cost Arab Nations $12 Billion, World Bank Says," *Bloomburg*, http://www.bloomberg.com/news/2012-12-05/ arab-climate-disasters-cost-12-billion-world-bank-report-says.html (accessed December 29, 2012).

13. Satish Kanady, "Rising Sea Level Poses Risk to Qatar, Neighbors," *The Peninsula Qatar*, http://www.thepeninsulaqatar.com/Display_news.asp?section=Local_News&month=November2009&file=Local_News200911281256.xml (accessed June 13, 2012).

14. Thomas Rogers, "The Flooded Earth: Which of Our Cities Can Be Saved?," *Salon*, http://www.salon.com/2010/07/06/the_flooded_earth_interview/ singleton/ (accessed June 13, 2012).

15. Emmanuelle Landais, "Waste dump threatens Arabian Gulf," *Gulf News* http://gulfnews.com/news/gulf/uae/environment/waste-dump-threatens-arabian-gulf-1.72058 (accessed January 11, 2014).

16. Oxford Dictionaries, s.v. "sabkha."

17. As of 2005, desalination plants were responsible for discharging in excess of 10,000,000 m3 of brine waste into the Gulf *per day.* This has likely increased as more desalination plants have come online in the intervening years. See A. Hashim and M. Hajjaj as mentioned in H.H. Al Barwani and Anton Punama, "Evaluating the Effect of Producing Desalinated Seawater on Hypersaline Arabian Gulf," *European Journal of Scientific Research*, 22, 2 (2008): 280.

18. *"Are We Running Out of Oil and Gas?." PetroStrategies, Inc. - Consulting, Research and Training. http://www.petrostrategies.org/ Learning_Center/are_we_running_out_of_oil_and_gas.htm (accessed July 2, 2012).*

19. "DSI > References > Tanks > 8 LNG tanks, Ras Laffan, Qatar ." DSI Group . http://www.dywidag-systems.com/emea/references/tanks/8-lng- tanks-ras-laffan-qatar.html (accessed July 2, 2012).

20. The distance from Basra to Musandam is 1,600 km. For the sake of comparison, the length of the Northeast corridor in the US, from Boston to Washington is 700 km.

21. *Qatar Population Status* 2012 Permanent Population Committee Oct 2012.