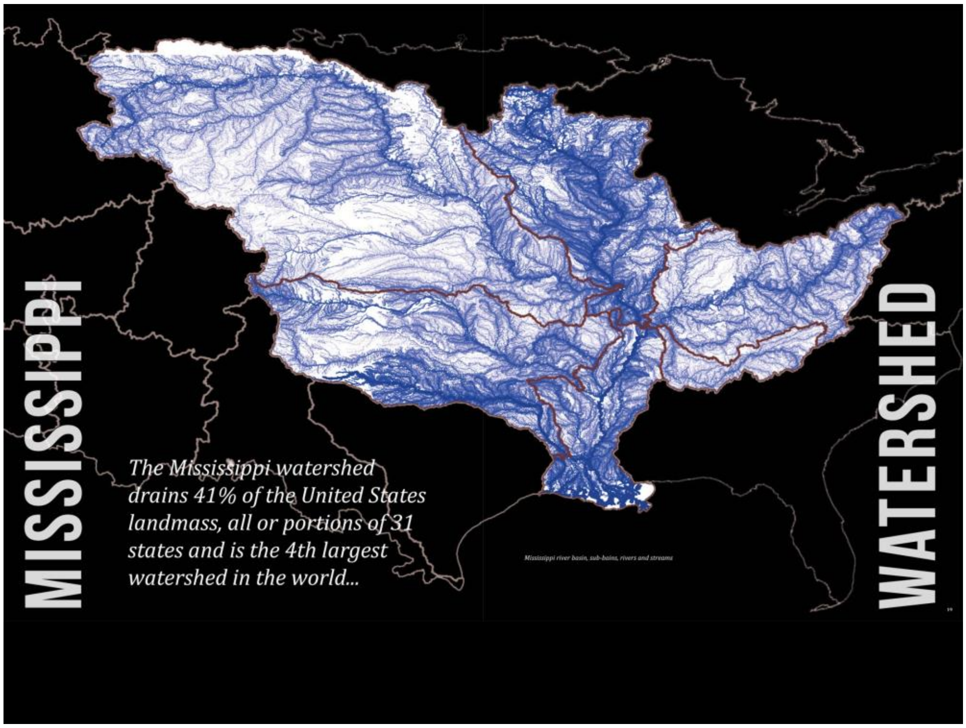
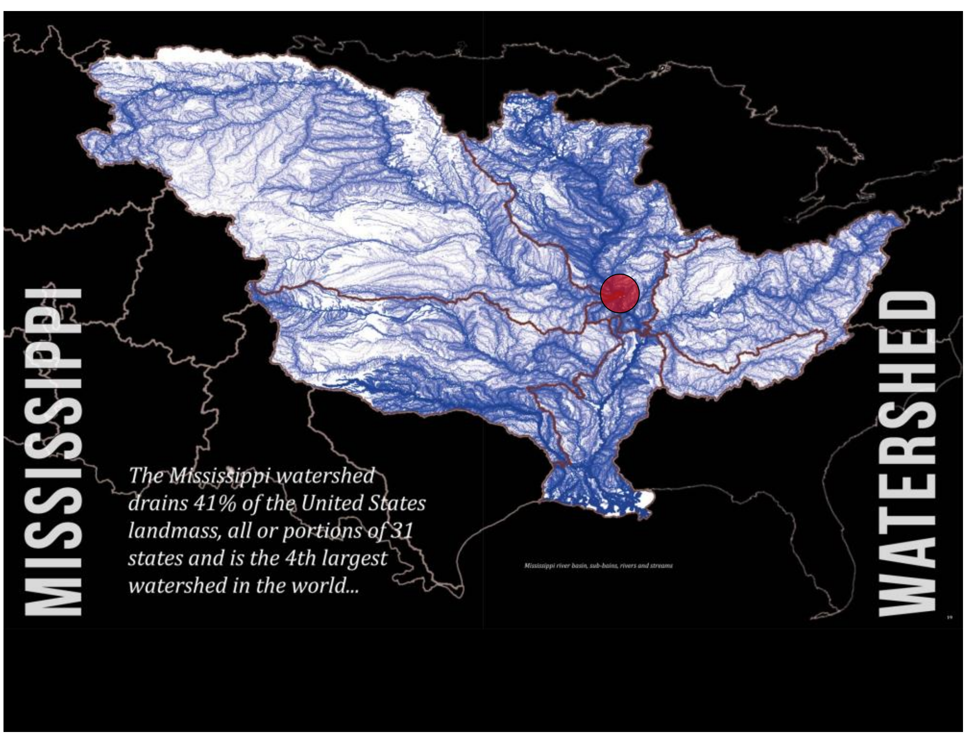

MISI-ZIIBI: LIVING WITH THE GREAT RIVERS
Climate Adaptation Strategies in the Midwest River Basins
John Hoal, Washington University in St. Louis | H3 Studio, Inc.
Derek Hoeferlin, Architect, Washington University in St. Louis
Dale Morris, Royal Netherlands Embassy, Washington D.C.
DELTAS IN TIMES OF CLIMATE CHANGE
ROTTERDAM, THE NETHERLANDS
September 26, 2014


St. Louis is in the heartland *on* the 4th Coast


MISSISSIPPI
WATERSHED
The Mississippi watershed drains 41% of the United States landmass, all or portions of 31 states and is the 4th largest watershed in the world...
Mississippi river basin, sub-basins, rivers and streams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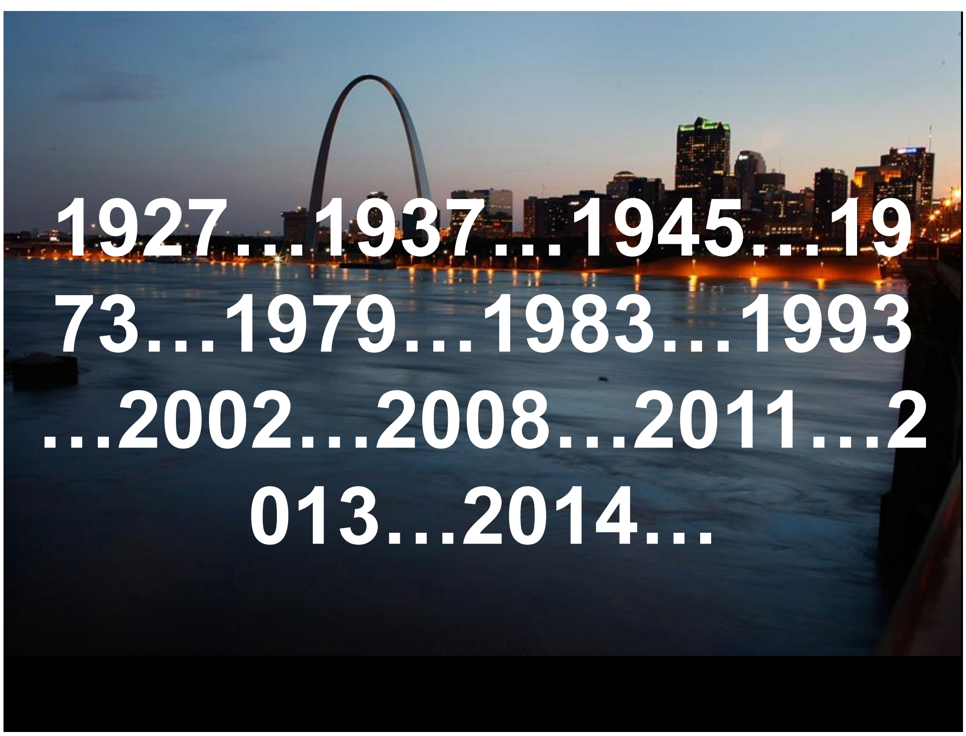
Mississippi river basin, sub-basins, rivers and streams


MISI-ZIIBI
LIVING WITH THE GREAT RIVERS
CLIMATE ADAPTATION STRATEGIES
IN THE MIDWEST RIVER BASINS
College & Graduate School of Architecture & Urban Design
Sam Fox School of Design and Visual Arts
Washington University in St. Louis
&
Royal Netherlands Embassy, Washington D.C.
John Hoal, Derek Hoeferlin, Dale Morris


1927…1937…1945…1973…1979…1983…1993…2002…2008…2011…2013…2014…


1927…
most destructive
flood in US history

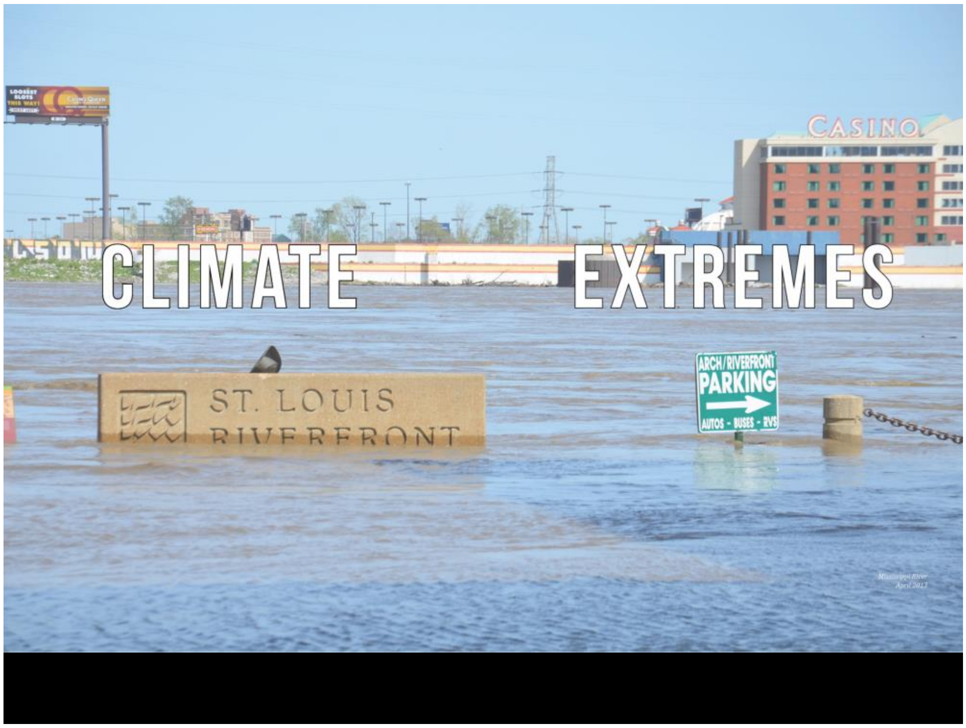

1993…
costliest
flood in US history

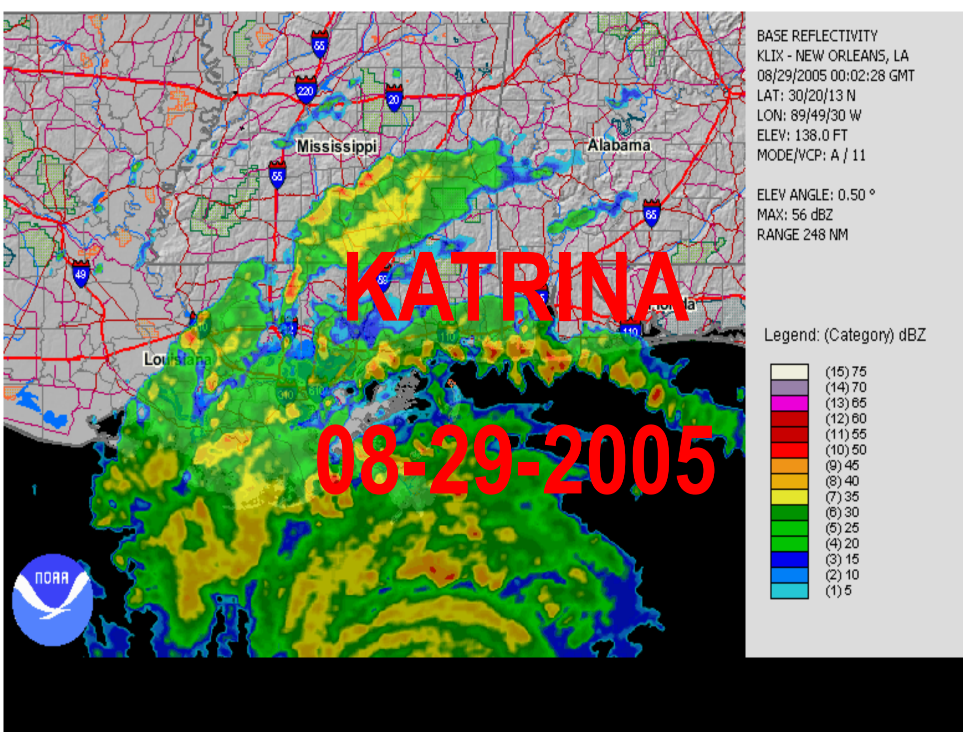

2011...
FLOOD
Wyatt, Missouri
May 2011

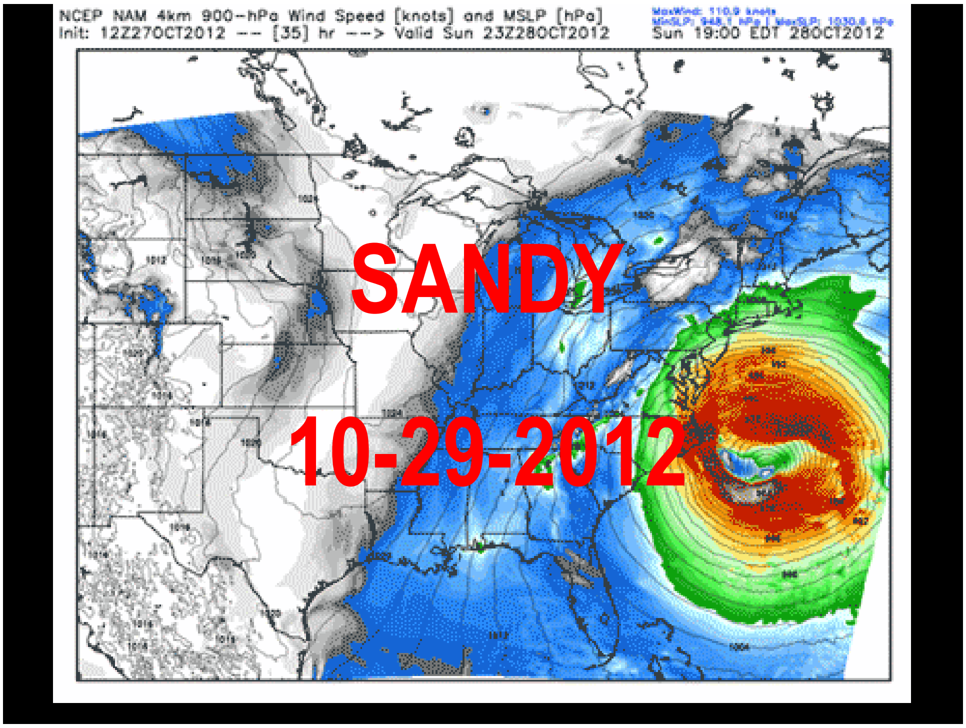

2012...
DROUGHT
Carmi, Illinois
July 2012


2013...
FLOOD


2014...
???


CLIMATE EXTREMES
CASINO
ST. LOUIS RIVERFRONT
ARCH/RIVERFRONT PARKING
AUTOS - BUSES - RVS


BASE REFLECTIVITY
KLIX - NEW ORLEANS, LA
08/29/2005 00:02:28 GMT
LAT: 30/20/13 N
LON: 89/49/30 W
ELEV: 138.0 FT
MODE/VCP: A / 11
ELEV ANGLE: 0.50 °
MAX: 56 dBZ
RANGE 248 NM
Legend: (Category) dBZ
(15) 75
(14) 70
(13) 65
(12) 60
(11) 55
(10) 50
(9) 45
(8) 40
(7) 35
(6) 30
(5) 25
(4) 20
(3) 15
(2) 10
(1) 5
Mississippi
Alabama
KATRINA
08-29-2005
NOAA


NCEP NAM 4km 900-hPa Wind Speed [knots] and MSLP [hPa]
Init: 12Z27OCT2012 -- [35] hr --> Valid Sun 23Z28OCT2012
Sun 19:00 EDT 28OCT2012
SANDY
10-29-2012

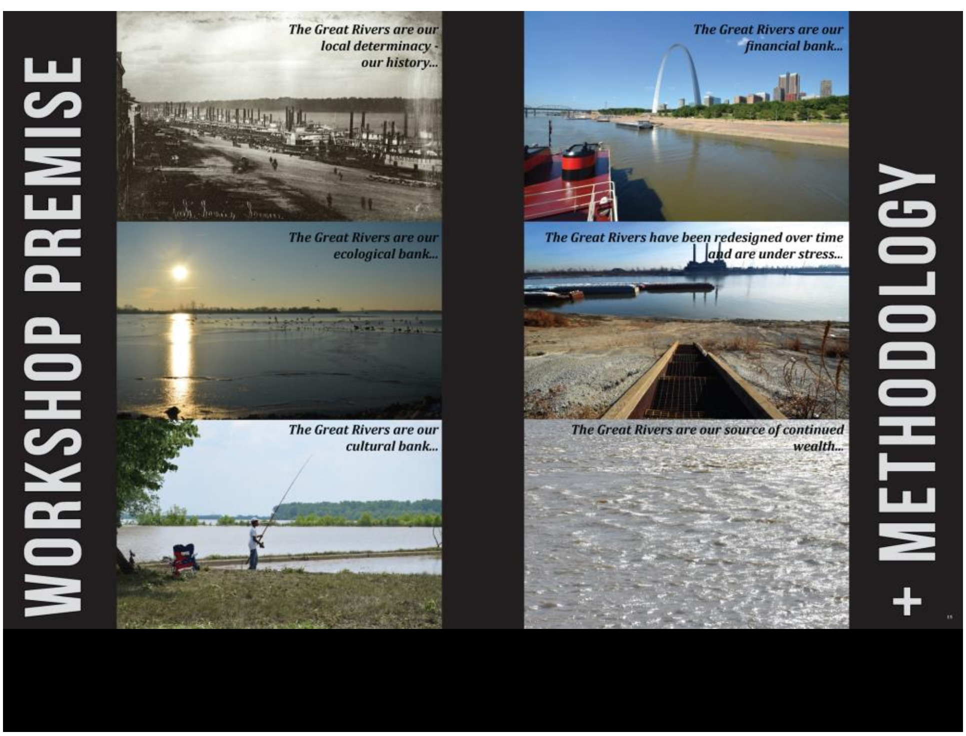

StormHighway.com


CLIMATE
CHANGE
IS NOT
JUST
COASTAL !!!
StormHighway.com


CONVENORS
College & Graduate School of Architecture & Urban Design
Sam Fox School of Design & Visual Arts, Washington University in St. Louis
John Hoal, Associate Professor, Chair, Master of Urban Design Program
Derek Hoeferlin, Assistant Professor
Dale Morris, Senior Economist
The Royal Netherlands Embassy, Washington D.C.
PARTNERS
American Rivers
Southern Illinois University Carbondale
Gephardt Institute for Public Service CGI U Programming Fund
International Center for Advanced Renewable Energy and Sustainability
Washington University in St. Louis
SAM FOX SCHOOL OF DESIGN & VISUAL ARTS
Kingdom of the Netherlands
MISI-ZIIBI
LIVING WITH THE GREAT RIVERS
Climate Adaptation Strategies in the Midwest River Basins


"MISI-ZIIBI"
OJIBWE NATIVE-AMERICAN NAME FOR
THE MISSISSIPPI RIVER, MEANING
"GREAT RIVER"
Historic bird's eye rendering of the Native American Cahokioa Mounds in the
American Bottom floodplain, Illinois -- just east of St. Louis, Missouri


WHERE ARE THE RIVERS ?


WORKSHOP PREMISE
The Great Rivers are our local determinacy - our history...
The Great Rivers are our ecological bank...
The Great Rivers are our cultural bank...
The Great Rivers are our financial bank...
The Great Rivers have been redesigned over time and are under stress...
The Great Rivers are our source of continued wealth...
+ METHODOLOGY


WATER


OPPORTUNITIES
OVER THE LONGTERM...
It is anticipated that there will be continued change to weather patterns in the Midwest which will alter how we live with & alongside our Great Rivers...
A NEW DESIGN CONDITION...
Challenges our current assumptions about flood risk, drought and water supply
Requires us to rethink how we use the river and adjacent lands
Requires us to adapt
Applies to both the entire river system as well as to our region
Impacts the economies, ecologies and communities along the river
A PROACTIVE LONG-TERM INTEGRATIVE WATER-BASED APPROACH...
Needs to simultaneously improve the economy, ecology and quality of our cities and towns
Has been developed, studied and implemented by the Dutch throughout the world
Becomes applicable to other mid-western cities and towns along the Great Rivers
Needs to build upon the previous work and commitment of the community
WE HAVE NO ANSWERS BUT PROPOSE A RESEARCH AGENDA AND A CONTINUING OF THE CONVERSATION...
Chain of Rocks water intake tower
Mississippi river during record low water levels
December 2012

MULTI-DISCIPLINARY, LOCAL, NATIONAL, INTERNATIONAL + DESIGN-BASED

MISI-ZIIBI: Living with the Great Rivers is a continuation of existing interactions between communities in the United States in partnership with the Royal Netherlands Embassy in Washington D.C. to reconsider issues around river environments. The recent Midwest floods, tornadoes and droughts are a demonstration that the increased climate variablity across the Mississippi and Missouri River basins have ramifications that require a change in how we live with and alongside our great rivers.

MISI-ZIIBI: Living with the Great Rivers built on the significant work that has been and is occuring in the St. Louis region an adding an additional factor. But is not a comprehensive approach and could not have been fully researched since the workshop took place over the course of only a weekend.

MISI-ZIIBI: Living with the Great Rivers is meant to illuminate the wealth and challenges of water, and to serve as a tool to aid communities, stakeholders, and government officials as they develop ways to respond to the climate challenges of the Midwest.

A DUTCH-AMERICAN COLLABORATION

MISI ZIIBI: Living with the Great Rivers follows numerous highly successful design-based workshops iniated by communities in the United States in partnership with The Royal Netherlands Embassy, Washington DC. This workshop brought Dutch engineers, landscape architects, planners and their respective American counterparts to the Midwest and Upper Mississippi/Missouri river basins. These were experts from the Netherlands' "Room for the River" program - a national program that addresses climate change, flood protection, drought tolerance, integrated land use, city planning, and the improvement of environmental conditions along rivers to ensure the continued sustainable development of The Netherlands' river region.

In the past, the Royal Netherlands Embassy has partnered with the city of New Orleans for a program called Dutch Dialogues, and continues to provide on-going workshops in Los Angeles and post-Sandy New York. The Royal Netherlands Embassy also consults throughout the world – in Thailand, Vietnam, Italy, and Indonesia.

The workshop interaction is a great way to facilitate dialogue and discussion with the local community and stakeholders. Most important to the success of the workshop is this interaction to receive critical local input.

Noordwaard Room for the River Project
Robbert de Koning Landscape Architects

7

A BALANCED APPROACH

WE...
LOOKED,
LISTENED TO LOCAL EXPERTS WITH MULTIPLE VIEWPOINTS,
LOOKED AGAIN,
LISTENED TO MORE LOCAL EXPERTS,
WERE INPIRED BY LOCAL, NATIONAL AND INTERNATIONAL CASE STUDIES,
DREW,
CALCULATED,
DISCUSSED,
DREW,
WORKED OUT WHAT ARE CRITICAL QUESTIONS AND UNKNOWNS AT THIS STAGE AND DISCUSSED,
AND DREW SOME MORE...

TO WORK OUT A PROPOSED RESEARCH AGENDA AND OPEN QUESTIONS RELEVANT TO MULTIPLE INTEREST GROUPS OF OUR OWN COMMUNITY AND COMMUNITIES ALONG OTHER GREAT RIVERS

Workshop Participants

WORKSHOP LEADERS
John Hoal, WUSTL (A)
Derek Hoeferlin, WUSTL (A)
Dale Morris, Embassy (A/D)

POLICY, ENGINEERING & REGIONAL
Hermjan Barneveld, HKV Consultants (D)
Frans Klijn, Deltares (D)
Pim Nijssen, City of Nijmejen (D)
Steven Slabbers, Bosch-Slabbers (D)
Ralph Schielen, Rijkswaterstaat (D)
John Hoal, WUSTL (A)
Derek Hoeferlin, WUSTL (A)
Dale Morris, Embassy (A/D)
Fredrik Huthoff, HKV Consultants / SIUC (D)
Eddie Brauer, USACE (A)
Christian Clerc, WUSTL (A)
Don Duncan, USACE (A)
John Kleinschmidt, Waggonner & Ball Architects (A)
Eileen Fretz, American Rivers (A)
Jon Remo, SIUC (A)
Jonathan Stitelman, WUSTL (A)
Richard “Rip” Sparks, Illinois Water Resources Center (retired) (A)
Todd Strole, TNC (A)
Chuck Theiling, Great River IWRM (A)
David Waggonner, Waggonner & Ball Architects, (A)
Bill Winston, WUSTL Earth & Planetary Sciences GIS lab (A)

Fluvial Zone Type 01: Agricultural Land Use & Pooled River
Mississippi River: Melvin Price Locks & Dam/Alton to Confluence of Illinois River
Robbert de Koning, Robbert de Koning Landscape Architect (D)
Chris van der Zwet (D)
Philip Burkhardt, WUSTL alum. (A)
Courtney Cushard, H3 Studio (A)
Carolyn Gaidis, L.A.N.D., LLC + H3 Studio (A)
Natalie Yates, WUSTL (A)
Students (Sherlock, Emily, Dan, Bin)

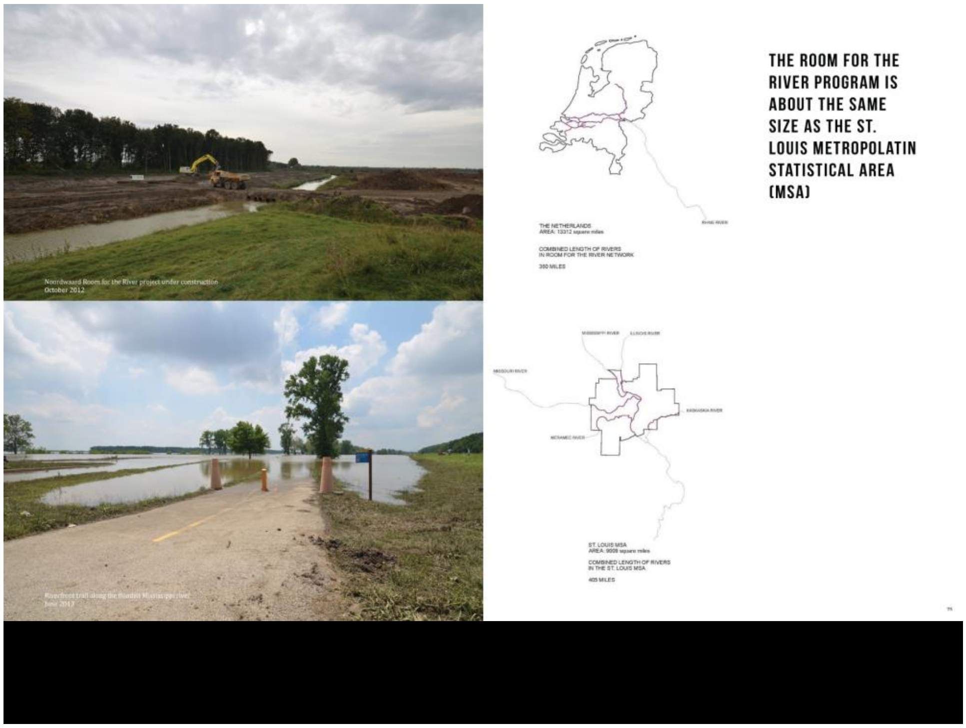
Fluvial Zone Type 02:
Levee Protected Future Suburban Development & Free Flow River
Missouri River: Howell Island State Wildlife Area to I-70
Peter Hermans (D)
Marten Hillen, Royal Haskoning (D)
Kees Lokman, WUSTL (D/A)
Irene Compadre, WUSTL alum. (A)
Bryan Robinson, H3 Studio (A)
Brendan Wittstruck, WUSTL alum. (A)
Students (Shinan, Deena, Sara)

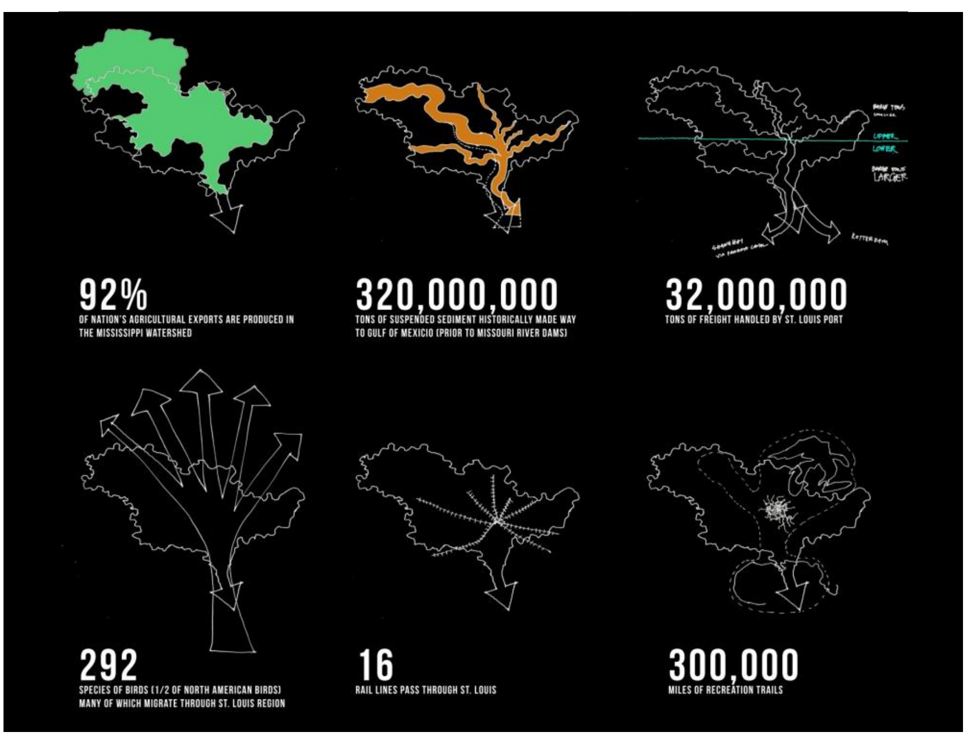
Fluvial Zone Type 03:
Levee Protected Existing Urbanized Area & Free Flow River
Mississippi River: Confluence to I-270/255
Stijn Koole (D)
Anne Sietske Verburg (D)
Craig Anz, SIUC (A)
Jesse Vogler, WUSTL (A)
Laura Lyon, H3 Studio (A)
Allison Mendez, WUSTL (A)
Mikey Naucus, WUSTL alum. (A)
Students (Tiffin, Chad, Golie, Alice)

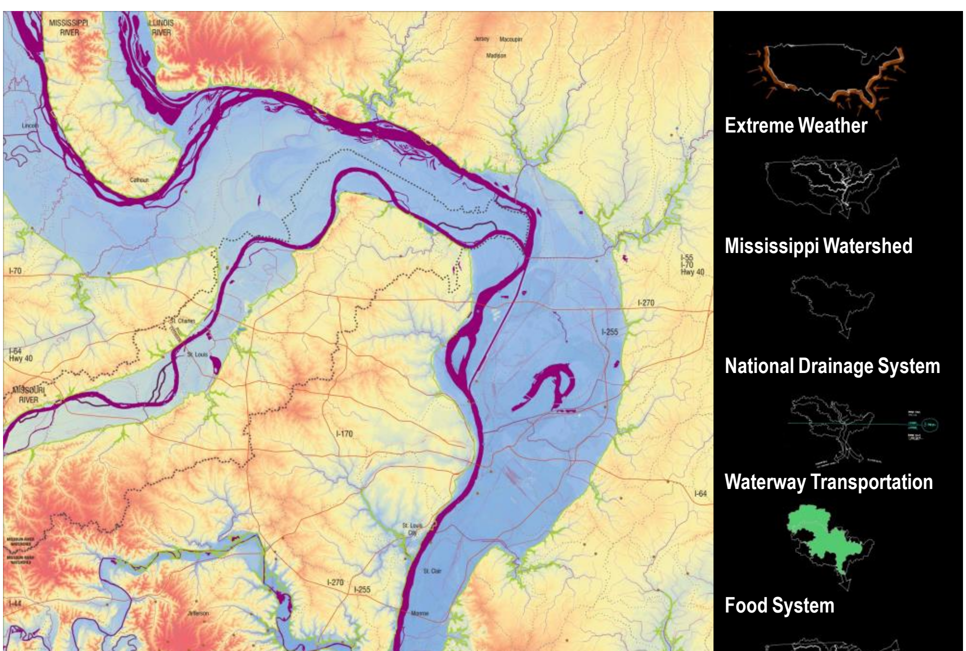
THE NETHERLANDS
IS NOT
THE MIDWEST

THE RHINE
IS NOT
THE MISSISSIPPI

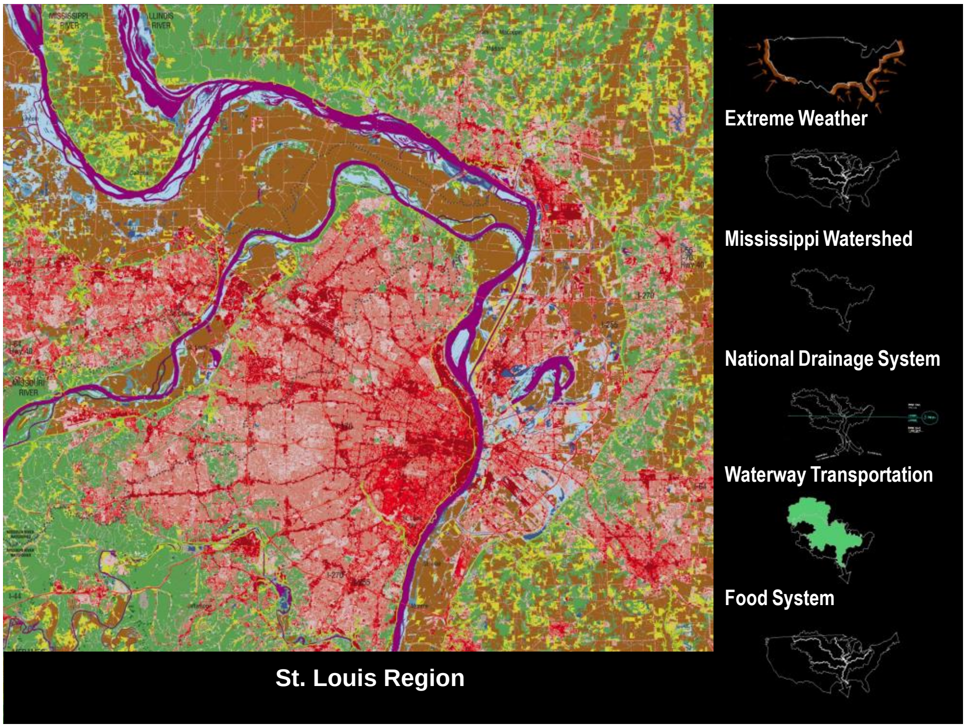
THE RHINE RIVER
BASIN
CAN FIT WITHIN
THE UPPER
MISSISSIPPI RIVER
BASIN

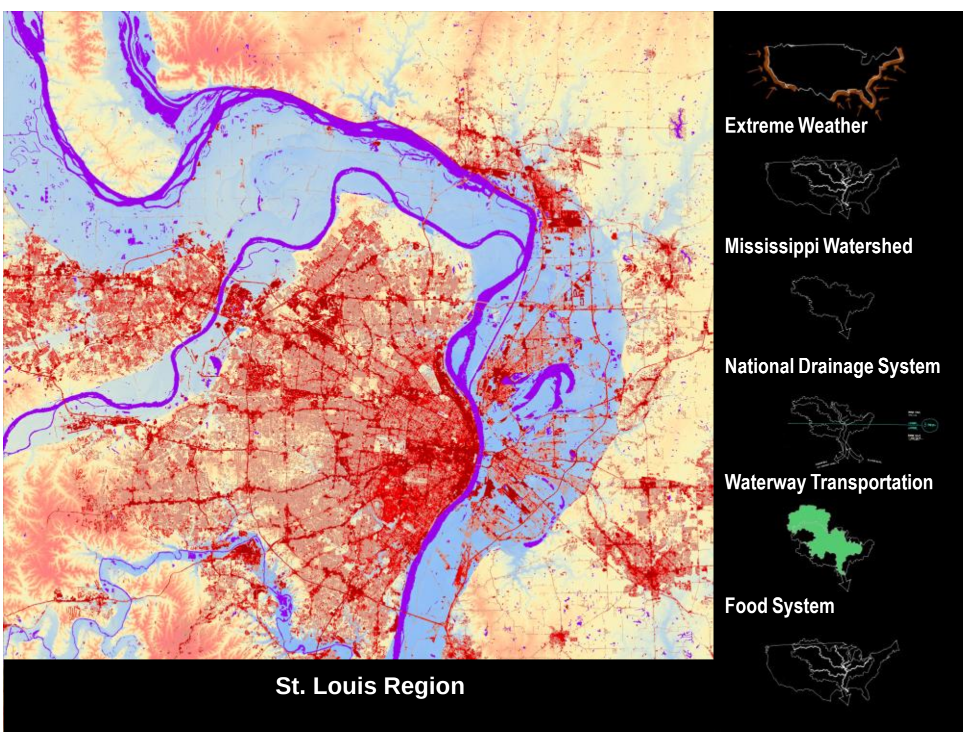

Noordwaard Room for the River project under construction
October 2012
THE ROOM FOR THE RIVER PROGRAM IS ABOUT THE SAME SIZE AS THE ST. LOUIS METROPOLATIN STATISTICAL AREA (MSA)
THE NETHERLANDS
AREA: 13312 square miles
COMBINED LENGTH OF RIVERS IN ROOM FOR THE RIVER NETWORK
350 MILES
MISSOURI RIVER
MERAMEC RIVER
KASKASKIA RIVER
ST. LOUIS MSA
COMBINED LENGTH OF RIVERS IN THE ST. LOUIS MSA
405 MILES


92%
OF NATION'S AGRICULTURAL EXPORTS ARE PRODUCED IN THE MISSISSIPPI WATERSHED
320,000,000
TONS OF SUSPENDED SEDIMENT HISTORICALLY MADE WAY TO GULF OF MEXICIO (PRIOR TO MISSOURI RIVER DAMS)
UPPER
LOWER
LARGER
32,000,000
TONS OF FREIGHT HANDLED BY ST. LOUIS PORT
292
SPECIES OF BIRDS (1/2 OF NORTH AMERICAN BIRDS) MANY OF WHICH MIGRATE THROUGH ST. LOUIS REGION
16
RAIL LINES PASS THROUGH ST. LOUIS
300,000
MILES OF RECREATION TRAILS



St. Louis Region


Extreme Weather
Mississippi Watershed
National Drainage System
Waterway Transportation
Food System
St. Louis Region


Extreme Weather
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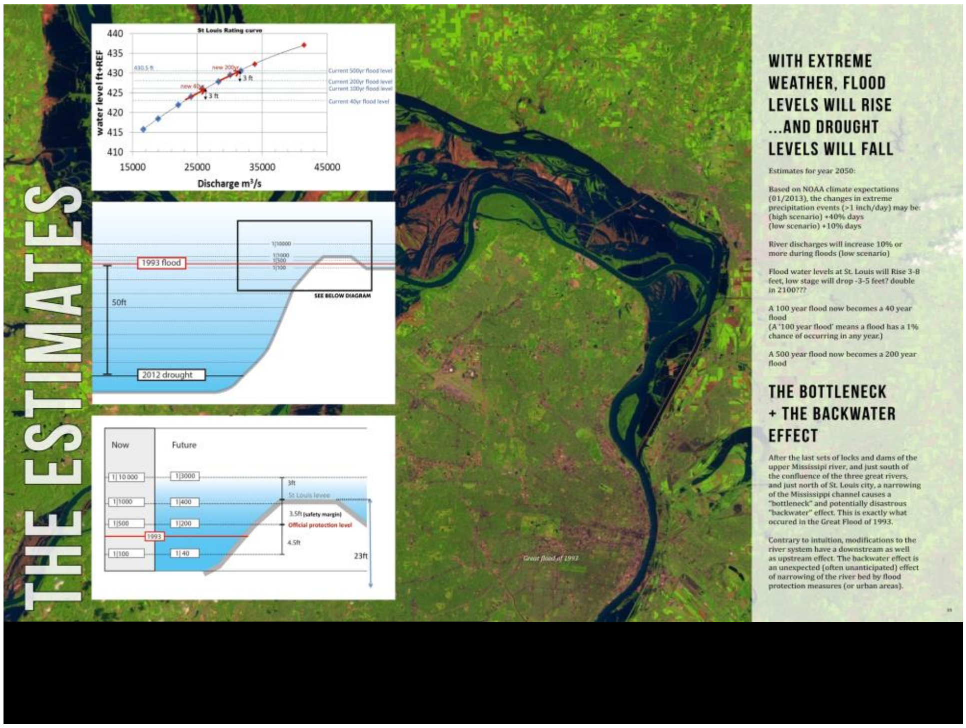
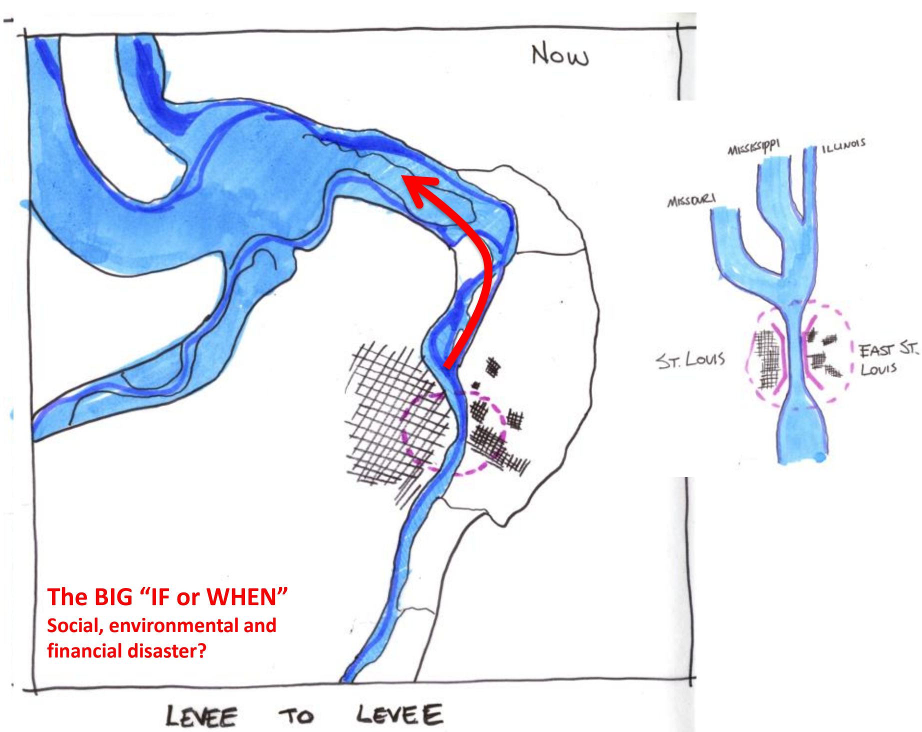

THE ESTIMATES
St Louis Rating curve
water level ft+REF
Discharge m³/s
1993 flood
2012 drought
50ft
SEE BELOW DIAGRAM
Now
Future
St Louis levee
Official protection level
23ft
Great flood of 1993
WITH EXTREME WEATHER, FLOOD LEVELS WILL RISE ...AND DROUGHT LEVELS WILL FALL
Estimates for year 2050:
Based on NOAA climate expectations (01/2013), the changes in extreme precipitation events (>1 inch/day) may be:
(high scenario) +40% days
(low scenario) +10% days
River discharges will increase 10% or more during floods (low scenario)
Flood water levels at St. Louis will Rise 3-8 feet, low stage will drop -3-5 feet? double in 2100???
A 100 year flood now becomes a 40 year flood
(A '100 year flood' means a flood has a 1% chance of occurring in any year.)
A 500 year flood now becomes a 200 year flood
THE BOTTLENECK + THE BACKWATER EFFECT
After the last sets of locks and dams of the upper Mississipi river, and just south of the confluence of the three great rivers, and just north of St. Louis city, a narrowing of the Mississippi channel causes a "bottleneck" and potentially disastrous "backwater" effect. This is exactly what occured in the Great Flood of 1993.
Contrary to intuition, modifications to the river system have a downstream as well as upstream effect. The backwater effect is an unexpected (often unanticipated) effect of narrowing of the river bed by flood protection measures (or urban areas).


Now
MISSISSIPPI
ILLINOIS
MISSOURI
ST. LOUIS
EAST ST. LOUIS
The BIG "IF or WHEN"
Social, environmental and financial disaster?
LEVEE TO LEVEE

If things go wrong…

Levee breach scenarios
Metro East Sanitary District
Current protection level: 500yr

In animation 1sec = 2hrs

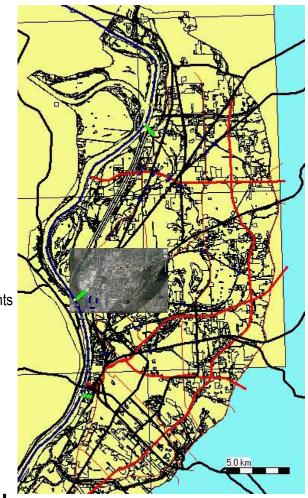
Direct flood damages
7 billion dollar structural damage

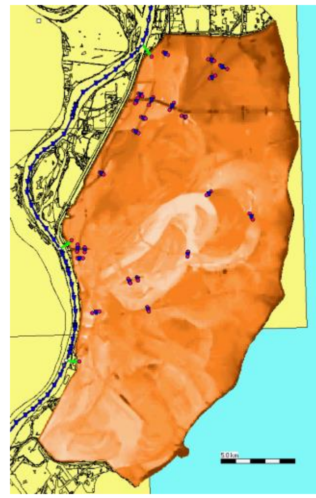
Indirect flood damages
Loss of business profits
(agriculture, navigation, etc)

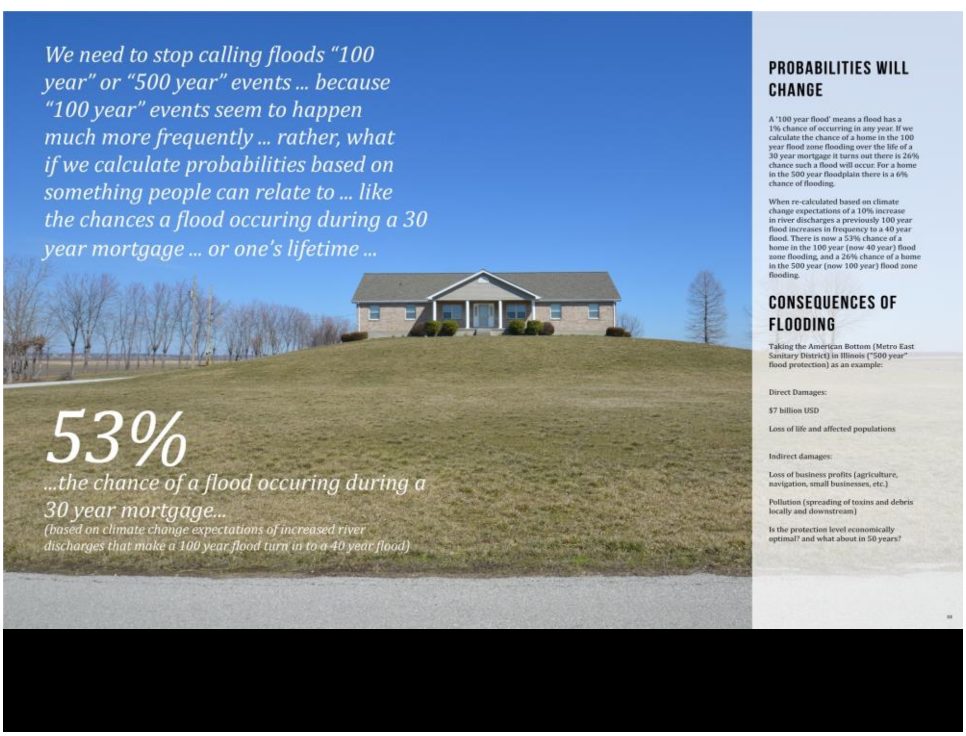
Pollution: spreading of debris and toxicants
(carried downstream)

Is the protection level economically optimal? and in 50 years?

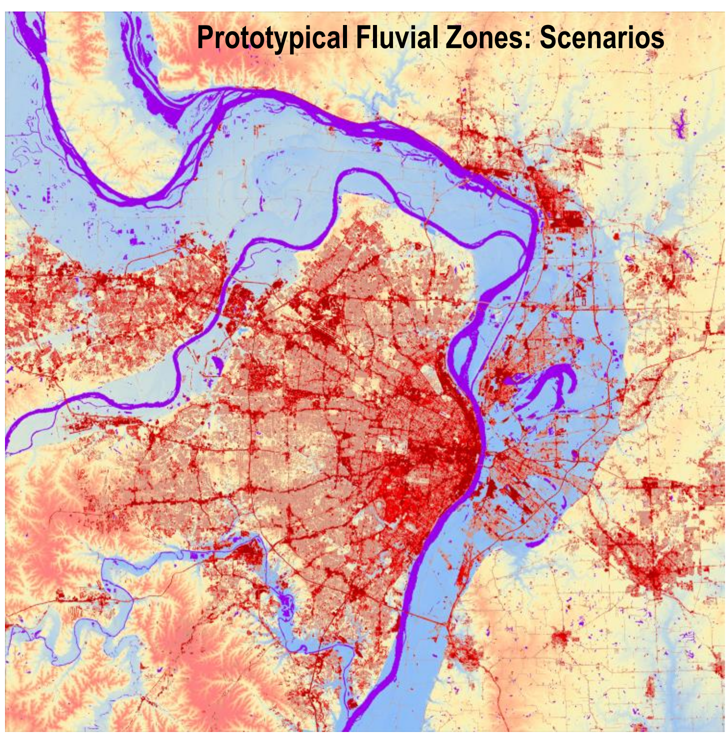
IT'S A TOXIC TIMB BOMB! -Frans Klijn

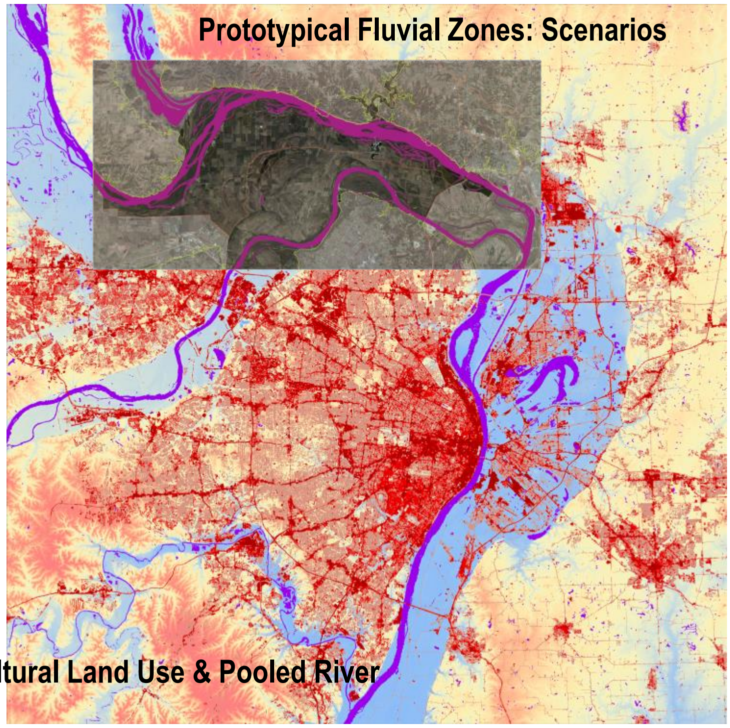






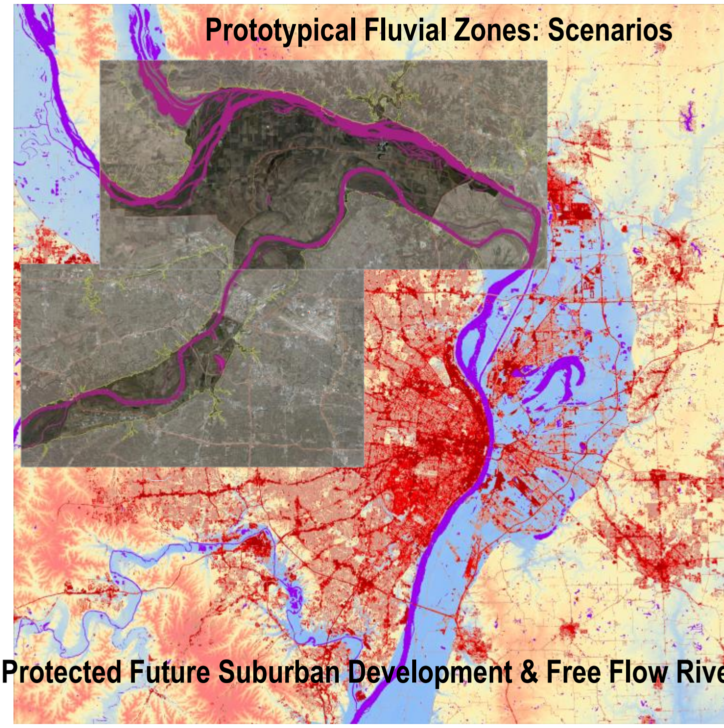

THE FLUVIAL ZONES
...the fluvial zones are prototypical of the upper midwest...agricultural, suburban, urban...free-flowing and pooled...
Confluence of the Missouri (left) and Mississippi (right) rivers


Prototypical Fluvial Zones: Scenarios



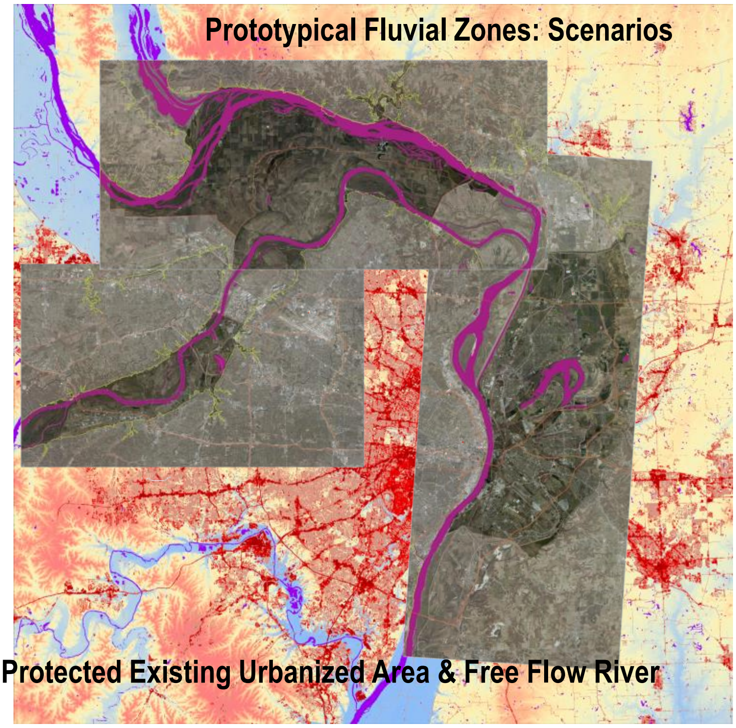
Agricultural Land Use & Pooled River

confluence flood plain (mississippi, missouri, illinois rivers)



Levee Protected Future Suburban Development & Free Flow River

missouri flood plain



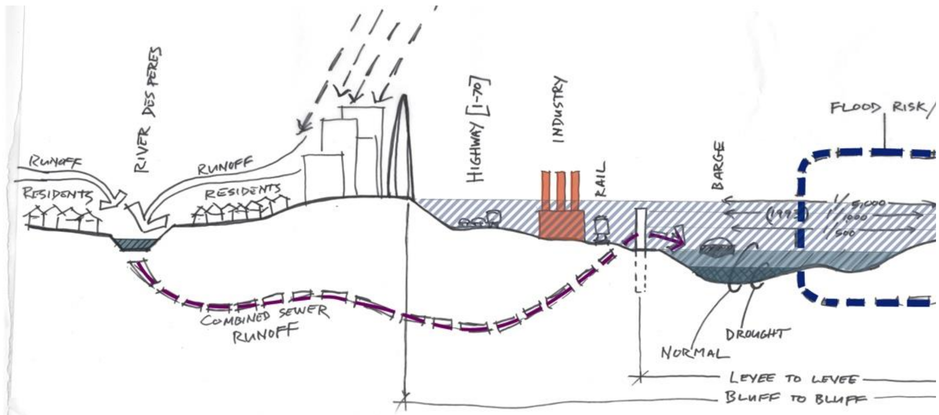
east st. louis flood plain (the american bottom)

Fluvial Zone Type 03:
Levee Protected Existing Urbanized Area & Free Flow River
Mississippi River: the Confluence to I-270/255

Fluvial Zone Type 03:
Levee Protected Existing Urbanized Area & Free Flow River
Mississippi River:
Confluence to 270/255

- **Second most populated floodplain in US**
- **Regional Bottle-neck in Mississippi River**
- **Historically important communities and site of Mississippian cultures and UNESCO Historic Site**
- **Heavy industry—Steel, Chemical, and Petrochemical**
- **Crossroads of industry, multi modal transit, agriculture**
- **Fragmentation—spatially, socially, etc**
- **All or nothing - single large levee system with zero redundancy**

The Challenges

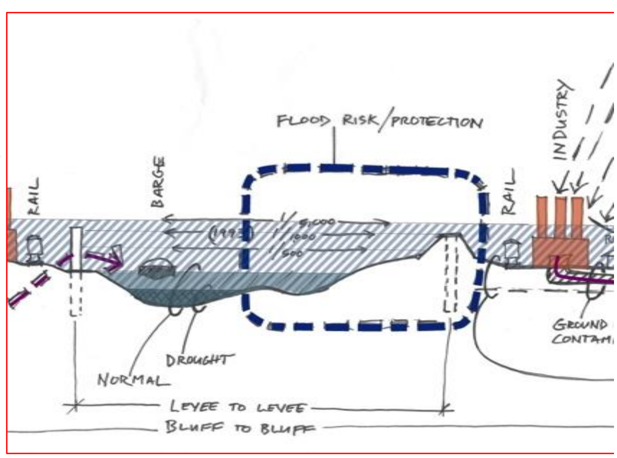


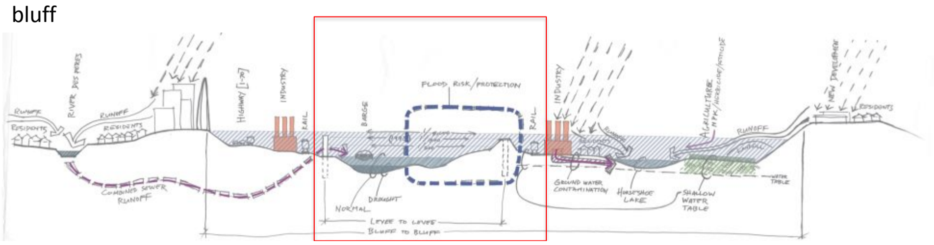
The Challenges

Flooding

Historically, this site is part of the major floodplain immediately below the confluence. Human interventions have created a regional bottleneck.

- Levee overtopping
- 'Funnel'/ Pinch
- Internal drainage in the American Bottoms from local surface water and tributaries on bluff



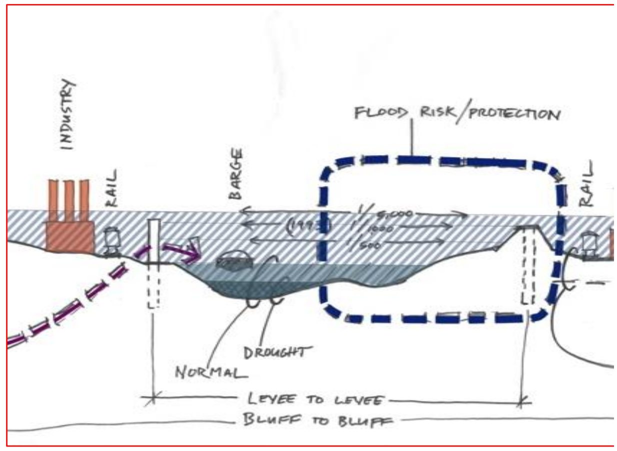


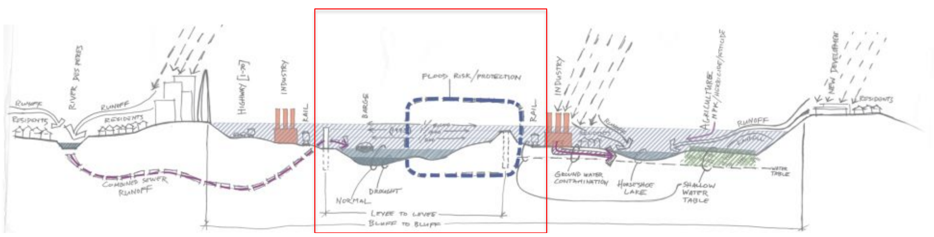
The Challenges

Drought

Poses specific problems to the barge industry and risks compromising water supply

Narrower channel due to sedimentation
Reduced number of barges
Impervious surfaces move water quickly
Heat Island Effect
Industry/ energy inlets?
Sedimentation in creeks





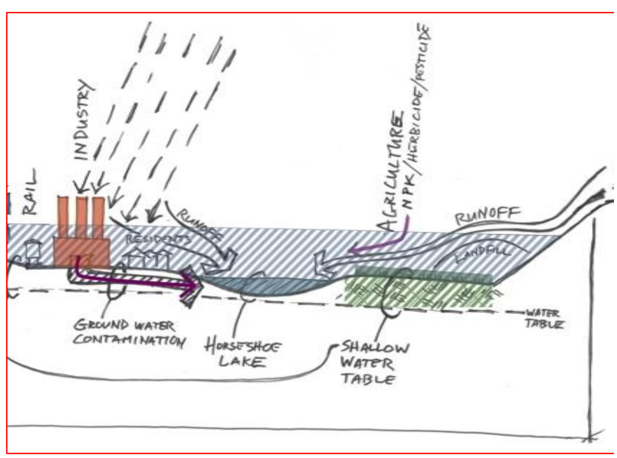
The Challenges

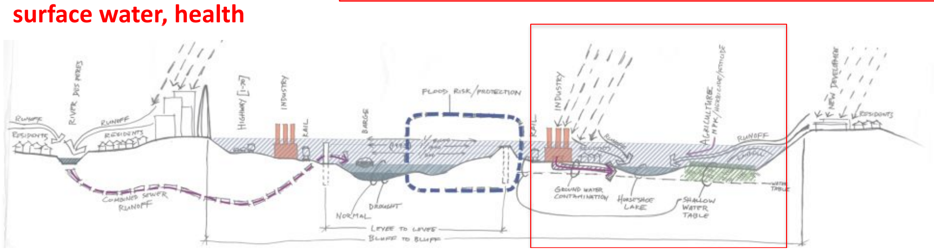
Contamination

A flood event risks contamination internally as well as the entire downstream watershed

Existing Industry
Brownfield Superfund sites
Water Supply
Agriculture
Sewage

Groundwater, soils, surface water, health





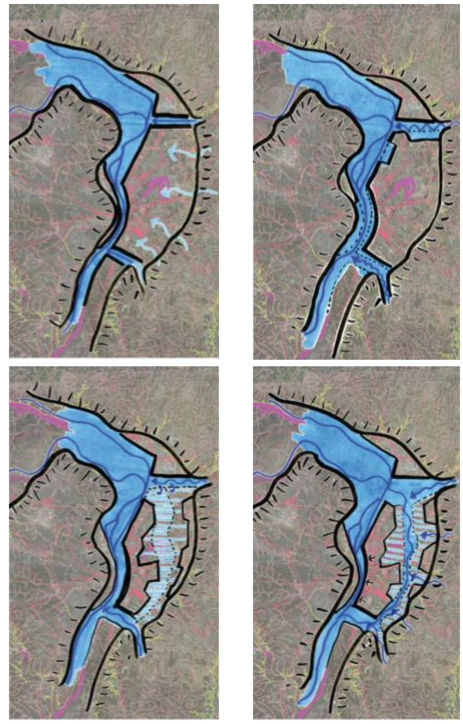
The Scenarios

Scenario 1:
Business as Usual

Scenario 2:
Set Back

Scenario 3:
Managed and Staged

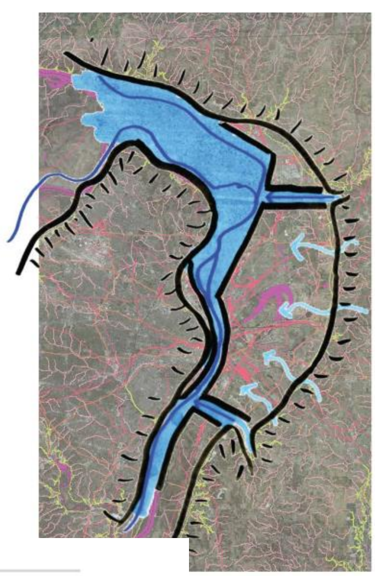
Scenario 4:
Blue Green Bypass

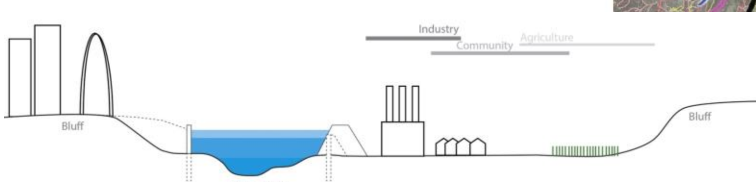


Scenario 1
Business as usual

+/Opportunities
•Safety within total area is ensured
•Contamination is contained within reinforced levee
•Least expensive

-/Challenges
•The river remains constricted
•Still an 'all-or-nothing' approach
•Zero redundancy
•Developed with East St. Louis's back to the river—does not add qualities to area

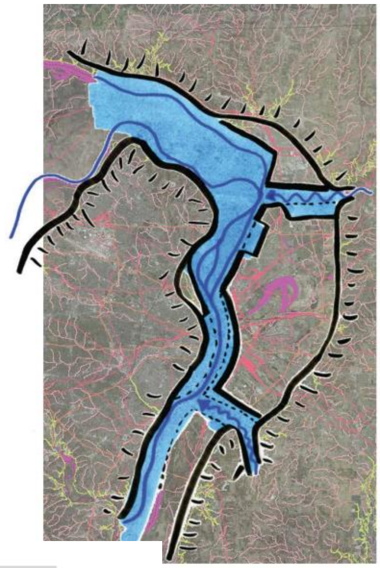


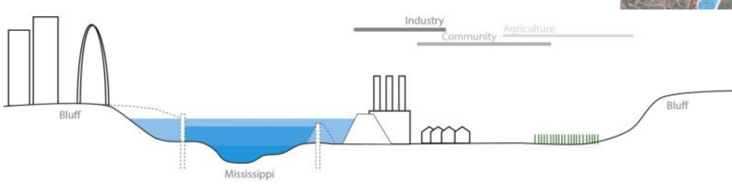


Scenario 2
Set Back

+/Opportunities
•Addresses bottleneck by expanding floodway
•Relieves larger system
•Contains majority of contaminants
•Increases protection to local levee district
•Opportunity for new waterfront/industry on Illinois side

-/Challenges
•Located in a historic area—must be sensitive to historic settlement patterns
•Industrial remediation along waterway
•Expense

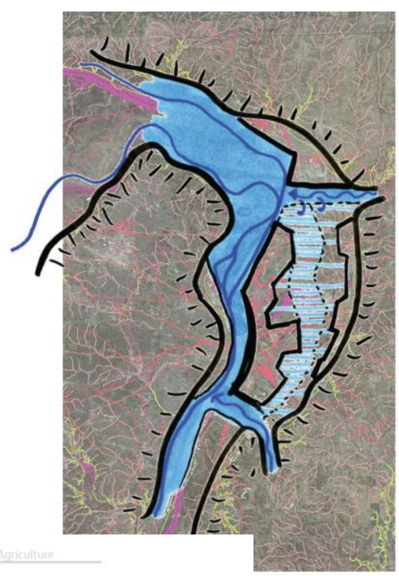


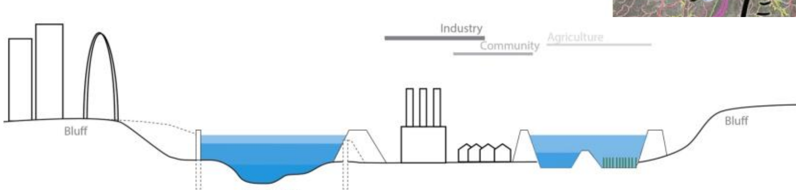


Scenario 3
Managed and staged floods

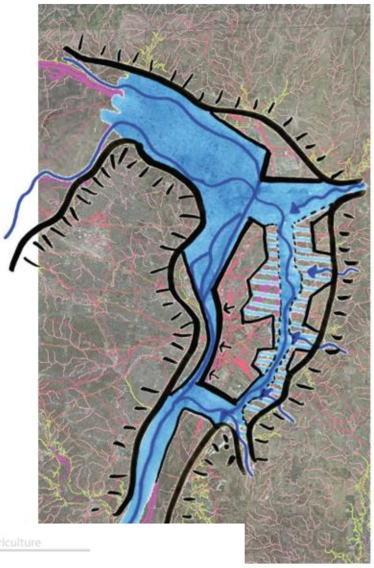
+/Opportunities
•Significant hydraulic relief for the entire system to have impacts on the national scale
•Protection of industry and containment of contaminants
•Bulk of the population protected by new levee
+/- Horseshoe Lake Remediation costly

-/Challenges
•Expensive to build and maintain levees
•Impacts majority of the agricultural community
•Some need for temporary inundation of agricultural lands





Scenario 4
Blue green by-pass

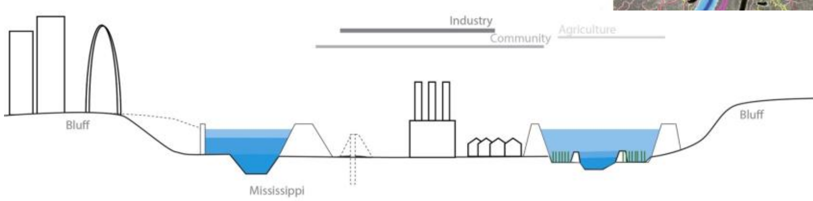


+/Opportunities

- Hydraulic Relief that functions on the national scale
- Major improvements to the local ecology, which will have positive impacts on the local area as well as the regional area
- Strengthens navigation while limiting uncertain flood-stages
- New development (port) opportunities along river

-/Challenges

- Modifies land use from agricultural to ecological
- Infrastructural blockages
- Cost/time



Continuing the Conversation…

EARTH ECONOMICS
ecosystem valuation toolkit

http://www.esvaluation.org

What Are Ecosytem Services?

Ecosystem services are benefits that people receive from natural systems. Ecosystem services require *natural capital*, such as a forest or marine ecosystem, with physical and/or nonphysical processes to support human activities and sustain life. For example, forest and soils are natural capital assets that provide the ecosystem service of filtering water naturally without need of a costly man-made filtration plant.

Four categories of ecosystem services:

PROVISIONING SERVICES produce food, water, oxygen, raw materials, fuel, clothing, medicine, etc. Everything in our economy is made from natural capital such as minerals, liquids, gases and living things.

REGULATING SERVICES create and maintain healthy environmental conditions. Examples are gas, and climate stability, flood and storm protection, water quality, soilerosion control, and disease and pest control. These contribute to healthy ecosystem functions.

INFORMATION SERVICES provide humans with meaningful interaction with nature. These services include spiritually significant species and natural areas, places for recreation, and educational opportunities through science.

HABITAT SERVICES provide refuge and reproduction habitat to wild plants and animals and thereby contribute to the (in situ) conservation of biological and genetic diversity and evolutionary processes.

http://www.esvaluation.org

Ecosytem Services

Provisioning

WATER SUPPLY Provisioning of drinking water, irrigation and industrial use.

FOOD Producing crops, fish, game and fruits.

ENERGY AND RAW MATERIALS Providing fuel, fiber, fertilizer, minerals and energy.

GENETIC RESOURCES Improve crop resistance to pathogens and pests

MEDICINAL RESOURCES Providing drugs, pharmaceuticals, tests, tools & assay organisms.

ORNAMENTAL RESOURCES Resources for clothing, jewelry, handicraft, worship and decoration.

Regulating

GAS REGULATION Providing clean, breathable air, disease prevention, and planet habitability.

CLIMATE STABILITY Promotes human health, crop productivity, and other climatic processes at global or local levels.

DISTURBANCE PREVENTION Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts

SOIL RETENTION Retaining arable land, slope stability and coastal integrity.

WATER REGULATION Natural irrigation, drainage, ground water recharge, river flows and navigation.

BIOLOGICAL CONTROL Providing pest and disease control.

WASTE TREATMENT Improving soil, water and air quality, pollution control/detoxification; breaking down of waste.

SOIL FORMATION Creating soils for agricultural and ecosystems integrity.

POLLINATION Pollination of wild and domestic plant species.

NUTRIENT REGULATION Promoting healthy soils, and gas, climate and water regulating services.

Information

AESTHETIC Enjoying and appreciating the scenery, sounds and smells.

RECREATION Experiencing natural ecosystems and outdoor activities.

SCIENCE & EDUCATION Using natural systems for education and scientific research.

CULTURAL AND ARTISTIC Using nature as motifs in art, film, folklore, books, cultural symbols, architecture and media.

Habitat

HABITAT AND BIODIVERSITY Maintaining genetic and biological diversity, the basis for most other functions.

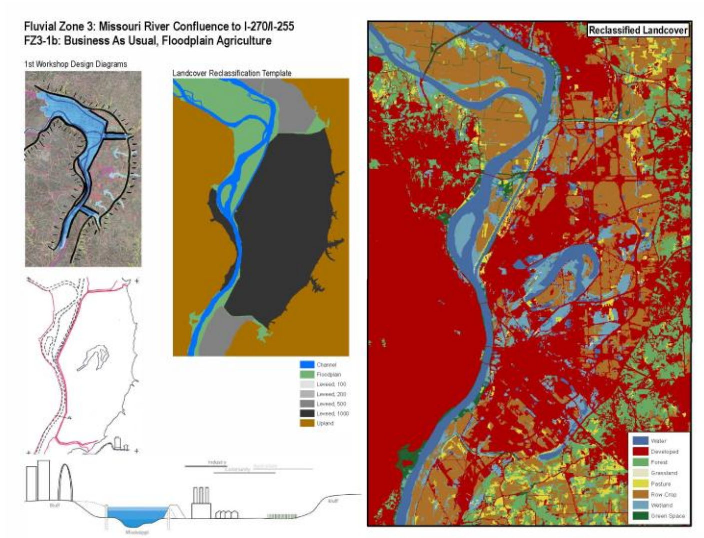
NURSERY Promoting growth of commercially harvested species.

Earth Economics | 107 N. Tacoma Avenue | Tacoma, WA 98403 | www.eartheconomics.org | info@eartheconomics.org | +1 253-539-4801

Eco-system Service Valuation Workshop
Earth Economics & US Army Corps of Engineers
September, 2013

Fluvial Zone 3
Scenario 1
Business as Usual, but better
Floodplain converted to agriculture

High Value
$2.6 billion



FZ3_1b: Business as Usual…Floodplain Agrictulture

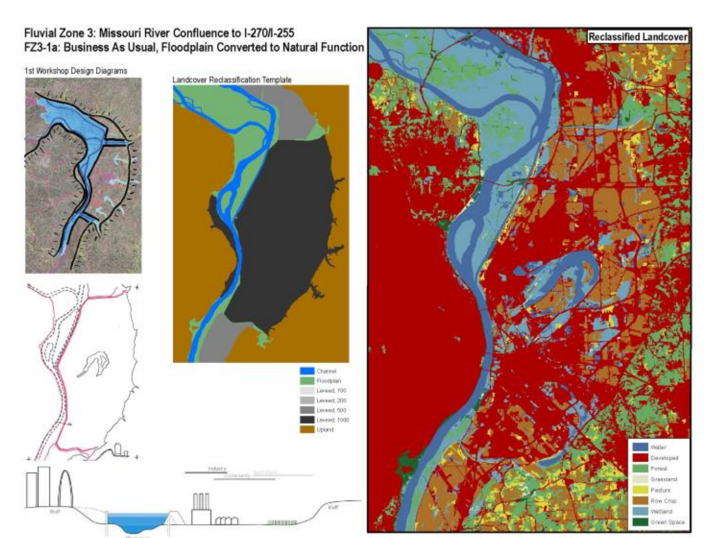
Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	61120	616	2,322	37,629,246	141,913,531
Forest	32200	5,163	18,942	166,262,821	609,922,369
Wetlands	21142	1,068	58,967	22,579,750	1,246,672,720
Grassland	417	712	867	296,941	361,658
Green Space	4403	656	23,844	2,889,918	104,982,000
River	21588	1,105	25,346	23,853,995	547,147,261
Pasture	11229	427	427	4,797,608	4,797,608
Developed Land	150062	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161		$	258,310,280 $	2,655,797,146

FZ3_1b: Business as Usual…Floodplain Agrictulture

Land Cover Class	Area (acres)	Data Source(s)/Layers Used
Agriculture	61120	NLCD 82
Forest	32,200	NLCD 40
Wetlands	21,142	NLCD 90
Grassland	417	NLCD 71
Green Space	4,403	NLCD 100
River	21,588	NLCD 11
Pasture	11,229	NLCD 81
Developed	150,062	NLCD 20
Total	302161	

Fluvial Zone 3
Scenario 1
Business as Usual, but better
Floodplain converted to natural function

High Value
$3.5 billion



FZ3_1a: Business as Usual…Floodplain Converted To Natural Function

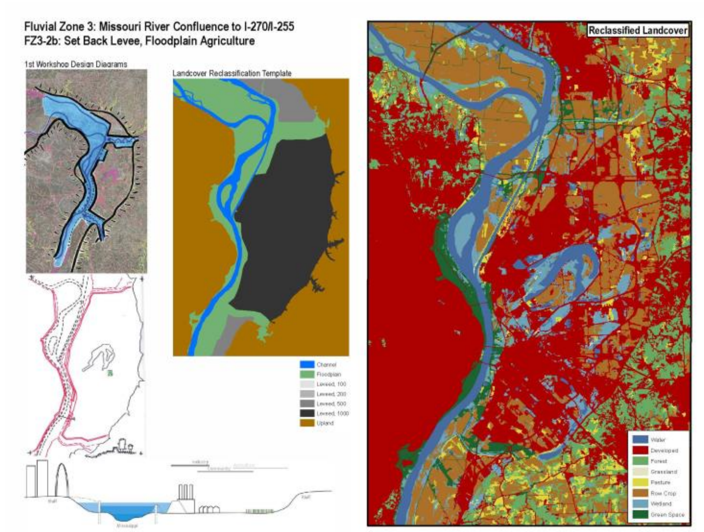
Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	42316	616	2,322	26,052,006	98,251,563
Forest	38157	5,163	18,942	197,020,534	722,754,670
Wetlands	36372	1,068	58,967	38,845,463	2,144,734,958
Grassland	919	712	867	654,379	796,998
Green Space	2964	656	23,844	1,945,681	70,680,699
River	21588	1,105	25,346	23,853,995	547,147,261
Pasture	9783	427	427	4,179,996	4,179,996
Developed Land	150062	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161		$	292,552,054 $	3,588,546,145

FZ3_1a: Business as Usual…Floodplain Agrictulture

Land Cover Class	Area (acres)	Data Source(s)/Layers Used
Agriculture	61120	NLCD 82
Forest	32,200	NLCD 40
Wetlands	21,142	NLCD 90
Grassland	417	NLCD 71
Green Space	4,403	NLCD 100
River	21,588	NLCD 11
Pasture	11,229	NLCD 81
Developed	150,062	NLCD 20
Total	302161	

Fluvial Zone 3
Scenario 2b
Set Back Levee
Floodplain converted
to agriculture

High Value
$2.8 billion



FZ3_2b: Set Back...Floodplain Agrictulture

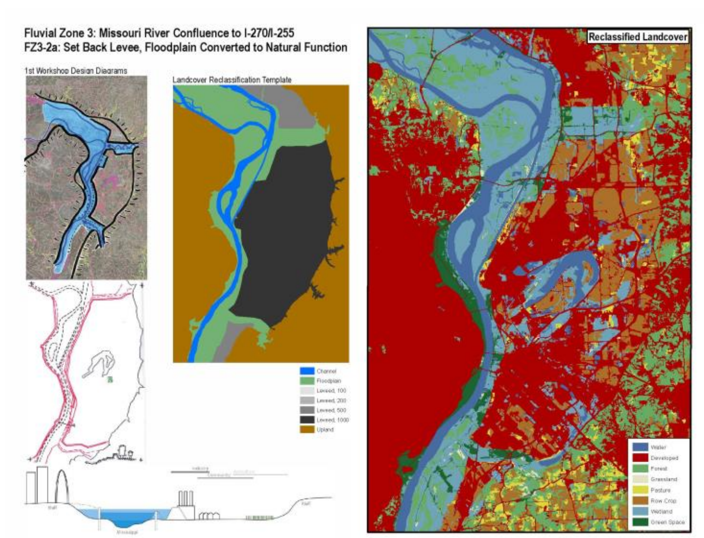
Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	61120	616	2,322	37,629,246	141,913,531
Forest	32200	5,163	18,942	166,262,821	609,922,369
Wetlands	21142	1,068	58,967	22,579,750	1,246,672,720
Grassland	417	712	867	296,941	361,658
Green Space	11547	656	23,844	7,579,366	275,335,442
River	21588	1,105	25,346	23,853,995	547,147,261
Pasture	11229	427	427	4,797,608	4,797,608
Developed Land	142917	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161			$ 262,999,727	$ 2,826,150,589

FZ3_2b: Set Back...Floodplain Agrictulture

Land Cover Class	Area (acres)	Data Source(s)/Layers Used
Agriculture	61120	NLCD 82
Forest	32,200	NLCD 40
Wetlands	21,142	NLCD 90
Grassland	417	NLCD 71
Green Space	11,547	NLCD 100
River	21,588	NLCD 11
Pasture	11,229	NLCD 81
Developed	142,917	NLCD 20
Total	302161	

Fluvial Zone 3
Scenario 2a
Set Back Levee
Floodplain converted
to natural function

High Value
$4.1 billion



FZ3_2a: Set Back...Floodplain Converted To Natural Function

Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	35491	616	2,322	21,850,613	82,406,587
Forest	40677	5,163	18,942	210,032,460	770,487,920
Wetlands	42385	1,068	58,967	45,267,360	2,499,300,620
Grassland	1165	712	867	829,429	1,010,199
Green Space	8919	656	23,844	5,854,494	212,676,075
River	21588	1,105	25,346	23,853,995	547,147,261
Pasture	9018	427	427	3,853,030	3,853,030
Developed Land	142917	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161			$ 311,541,382	$ 4,116,881,693

FZ3_2a: Set Back...Floodplain Converted To Natural Function

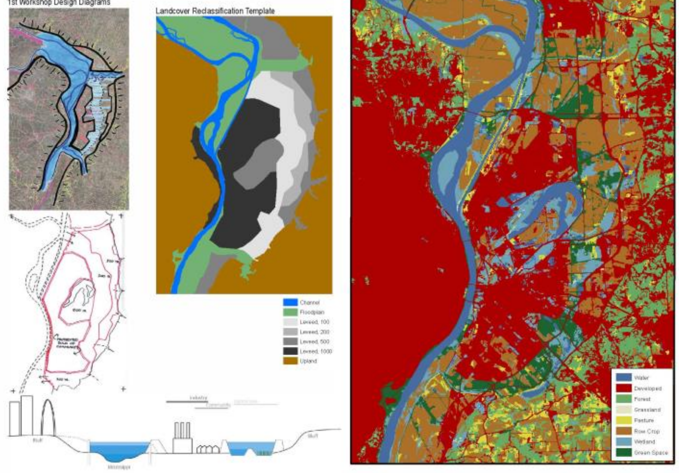
Land Cover Class	Area (acres)	Data Source(s)/Layers Used
Agriculture	35491	NLCD 82
Forest	40,677	NLCD 40
Wetlands	42,385	NLCD 90
Grassland	1,165	NLCD 71
Green Space	8,919	NLCD 100
River	21,588	NLCD 11
Pasture	9,018	NLCD 81
Developed	142,917	NLCD 20
Total	302161	

Fluvial Zone 3
Scenario 3b
Managed and staged floods
Floodplain converted to agriculture

High Value
$2.9 billion

Fluvial Zone 3: Missouri River Confluence to I-270/I-255
FZ3-3b: Managed and Staged Floods, Floodplain Agriculture

1st Workshop Design Diagrams



FZ3_3b: Managed and Staged Flood...Floodplain Agrictulture

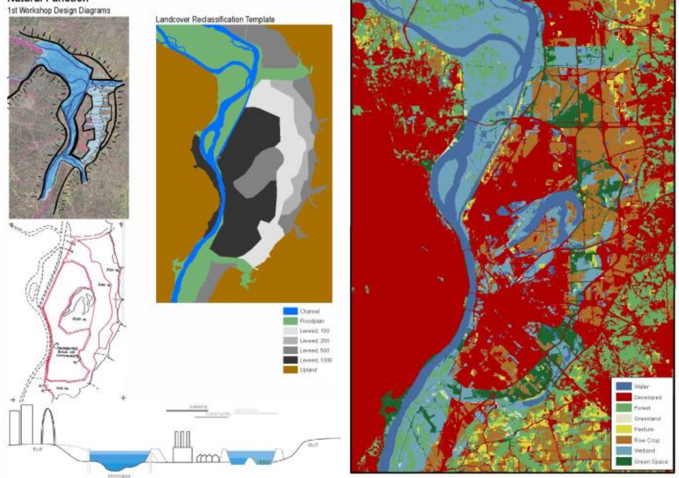
Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	61120	616	2,322	37,629,246	141,913,531
Forest	32200	5,163	18,942	166,262,821	609,922,369
Wetlands	21142	1,068	58,967	22,579,750	1,246,672,720
Grassland	417	712	867	296,941	361,658
Green Space	14616	656	23,844	9,593,719	348,510,803
River	21588	1,105	25,346	23,853,995	547,147,261
Pasture	11229	427	427	4,797,608	4,797,608
Developed Land	139849	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161			$ 265,014,081	$ 2,899,325,949

Fluvial Zone 3
Scenario 3a
Managed and staged floods
Floodplain converted to natural function

High Value
$4.1 billion

Fluvial Zone 3: Missouri River Confluence to I-270/I-255
FZ3-3a: Managed and Staged Floods, Floodplain Converted to Natural Function

1st Workshop Design Diagrams



FZ3_3a: Managed and Staged Flood...Floodplain Converted To Natural Function

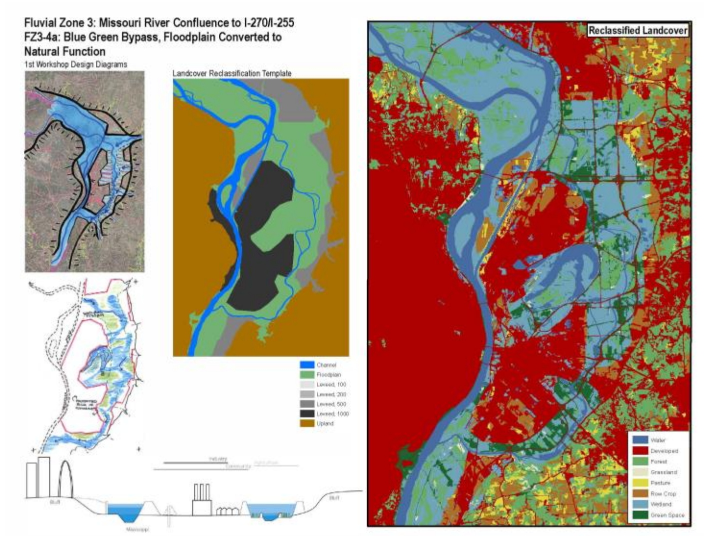
Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	37110	616	2,322	22,847,019	86,164,395
Forest	40050	5,163	18,942	206,794,087	758,608,200
Wetlands	40477	1,068	58,967	43,230,260	2,386,828,282
Grassland	1137	712	867	809,809	986,303
Green Space	12619	656	23,844	8,282,861	300,891,286
River	21588	1,105	25,346	23,853,995	547,147,261
Pasture	9331	427	427	3,986,724	3,986,724
Developed Land	139849	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161			$ 309,804,756	$ 4,084,612,452

FZ3_3a: Managed and Staged Flood... Floodplain Converted To Natural Function

Land Cover Class	Area (acres)	Data Source(s)/Layers Used
Agriculture	37110	NLCD 82
Forest	40,050	NLCD 40
Wetlands	40,477	NLCD 90
Grassland	1,137	NLCD 71
Green Space	12,619	NLCD 100
River	21,588	NLCD 11
Pasture	9,331	NLCD 81
Developed	139,849	NLCD 20
Total	302161	

Fluvial Zone 4
Scenario 4a
Blue Green Bypass
Floodplain converted
to natural function

High Value
$4.8 billion



FZ3_4a: Blue-Green Bypass...Floodplain Converted To Natural Function

Land Cover Class	Area (acres)	Low Value ($/acre/year)	High Value ($/acre/year)	Low Value ($/year)	High Value ($/year)
Agriculture	24597	616	2,322	15,143,480	57,111,554
Forest	44809	5,163	18,942	231,364,302	848,742,143
Wetlands	51832	1,068	58,967	55,357,035	3,056,371,570
Grassland	1275	712	867	908,191	1,106,127
Green Space	13010	656	23,844	8,539,563	310,216,512
River	23141	1,105	25,346	25,570,352	586,515,919
Pasture	8573	427	427	3,662,704	3,662,704
Developed Land	134924	Not Valued	Not Valued	Not Valued	Not Valued
TOTAL	302,161			$ 340,545,627	$ 4,863,726,529

FZ3_4a: Blue-Green Bypass...
Floodplain Converted To Natural Function

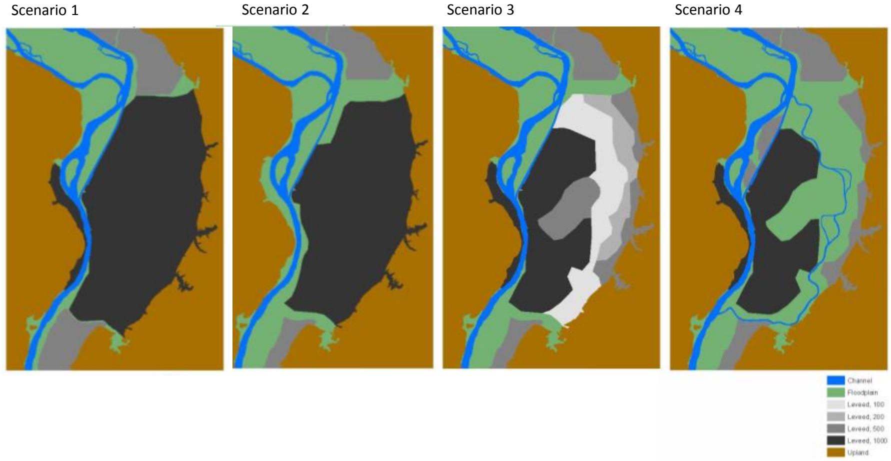
Land Cover Class	Area (acres)	Data Source(s)/Layers Used
Agriculture	24597	NLCD 82
Forest	44,809	NLCD 40
Wetlands	51,832	NLCD 90
Grassland	1,275	NLCD 71
Green Space	13,010	NLCD 100
River	23,141	NLCD 11
Pasture	8,573	NLCD 81
Developed	134,924	NLCD 20
Total	302161	

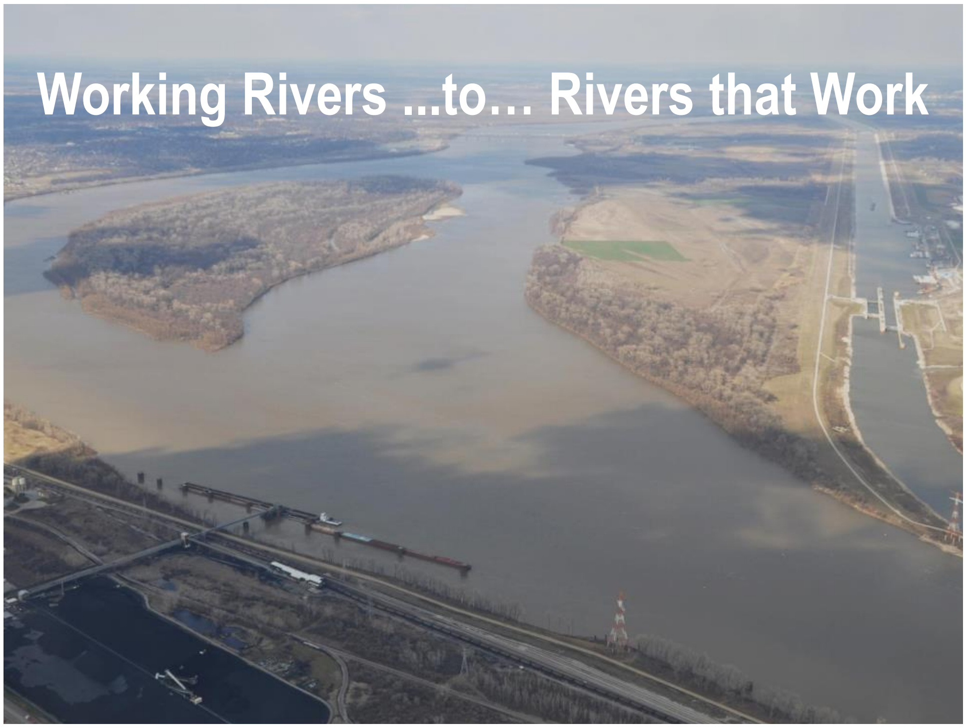
Earth Economics Workshop
Eco-System valuation

September 2013

$2.6b *$4.1b* *$4.1b* *$4.6b*

Scenario 1 Scenario 2 Scenario 3 Scenario 4




Working Rivers ...to... Rivers that Work


Working Rivers ...to... Rivers that Work
RESEARCH AGENDA ... CONTINUING THE CONVERSATION
• Validate the discharge and water level data, flood and drought impacts and establish future hydrological design conditions based upon climate change / extreme weather scenarios
• Evaluate options for risk management for flood and drought control, spatial planning, contaminants, and disaster management
• Develop a more integrated vision for land-use and multi-layered and functional infrastructure
• Create new (sustainable) economic generators
• Continue building community capacity to foster dialogue around these issues
• Build a multi-disciplinary international “think tank” dedicated to the research and practice of long-term integrative water-based planning


Thank you