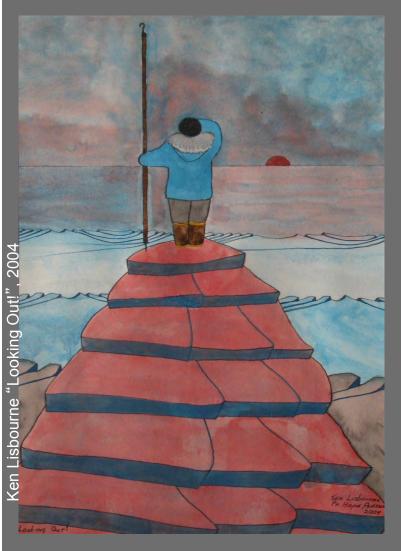
## Planning for Arctic Futures: A glimpse at interdisciplinary scenario modeling and analysis



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Fairbanks, AK 99775-7320, USA e-mail: hajo.eicken@gi.alaska.edu

#### Further reading:

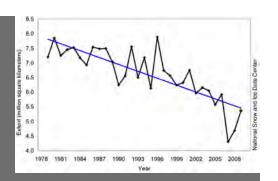
- Borjeson et al. 2006. Scenario types and techniques: Towards a user's guide. Futures 38, 723-739.
- Brigham, L.W., 2007. Thinking about the Arctic's Future: Scenarios for 2040. Futurist 41, 27-34.
- Mueller-Stoffels, M.M. & H. Eicken, 2011. Futures of Arctic Marine Transport 2030: An Explorative Scenario Approach. In Lovecraft & Eicken, North by 2020: Perspectives on Alaska's changing social-ecological systems. UA Press, 477-489.
- Shell International, 2008. Scenarios: An explorer's guide. Online at: http://www.shell.com/global/future-energy/scenarios/explorers-guide.html



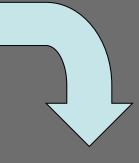
Barrow whaling camp (Photo: Bill Hess)

## A changing North

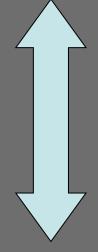
Regime shifts in climate and the environment about to exceed range of recent past variability and change



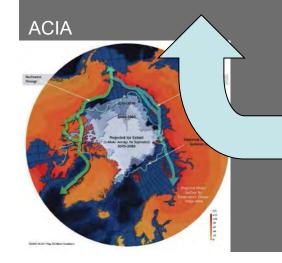
**NSIDC** 



Sweeping impacts of change on Northern populations and cultures



Increasing interdependence between the Arctic region and global processes



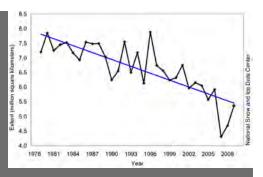
Expansion of global geopolitical and economic interests into the North





Barrow whaling camp (Photo: Bill Hess)

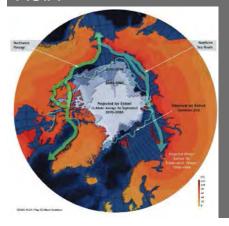
## A changing North



**NSIDC** 

How can stakeholders best anticipate the challenges and take advantage of the opportunities that come with a rapidly changing North?

**ACIA** 



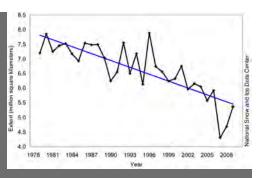
BP Northstar





Barrow whaling camp (Photo: Bill Hess)

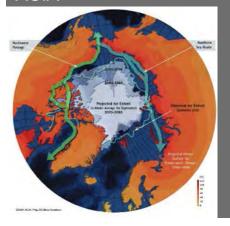
## A changing North



**NSIDC** 

How can we best utilize different approaches in prediction and observing systems to track and project such change in interdisciplinary settings?

**ACIA** 



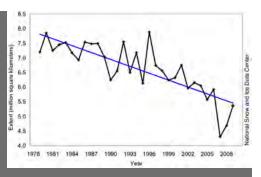
BP Northstar





Barrow whaling camp (Photo: Bill Hess)

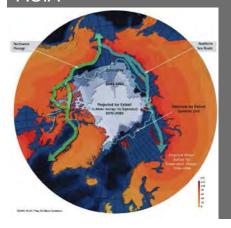
## A changing North



**NSIDC** 

How can we ensure that the resulting information is relevant and useful to decision-makers or stakeholders?

**ACIA** 



**BP Northstar** 



## Five approaches to anticipate futures

Forecasting: Quantitative prediction of outcomes based on conceptual or mathematical models

Foresight: Systematic, mostly qualitative exploration of full range of plausible future outcomes

- Stationarity
- Simplified (analytical or complex) system models
- Analogs (paleo, historical, geographical)
- Numerical system
   models (climate models,
   earth system models)

- Scenarios and foresight
  - expert assessments(narratives, refined analyses)

## Scenarios on the Future of **Arctic Marine Navigation in 2050**

**AMSA** Brigham

more demand

#### Arctic Race

High demand and unstable governance set the stage for a "no holds barred" rush for Arctic wealth and resources.

#### Arctic Saga

High demand and stable governance lead to a healthy rate of development, includes concern for preservation of Arctic ecosystems & cultures.

unstable & ad-hoc

GOVERNANCE

stable & rules-based

#### Polar Lows

Low demand and unstable governance bring a murky and under-developed future for the Arctic.

#### Polar Preserve

Low demand & stable governance slow development in the region while introducing an extensive eco-preserve with stringent "no-shipping zones".

less demand

AMSA/GBN Scenarios Workshops ~ April & July 2007 The Future of Arctic Marine Navigation in 2050

### Scenario elements

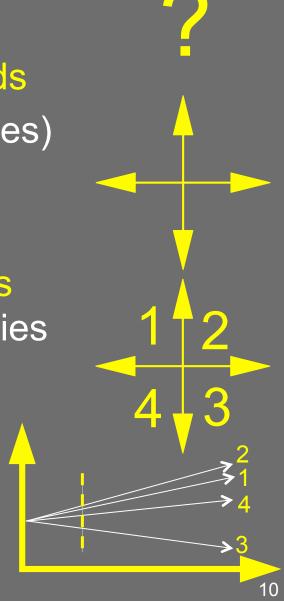
- Scenario: an internally consistent, plausible vision of the future (typically several decades out); typically considered as a bundle of scenarios that defines a plausible decision space
- Defining question (DQ)
- Participation & knowledge co-production: Expert/ stakeholder consultation & involvement
- Summary/synthesis of available information on present state and trends relevant to DQ
- Key drivers or factors; key uncertainties; indicators;
   driver/uncertainty bundles = specific scenarios

## Scenario/foresight history

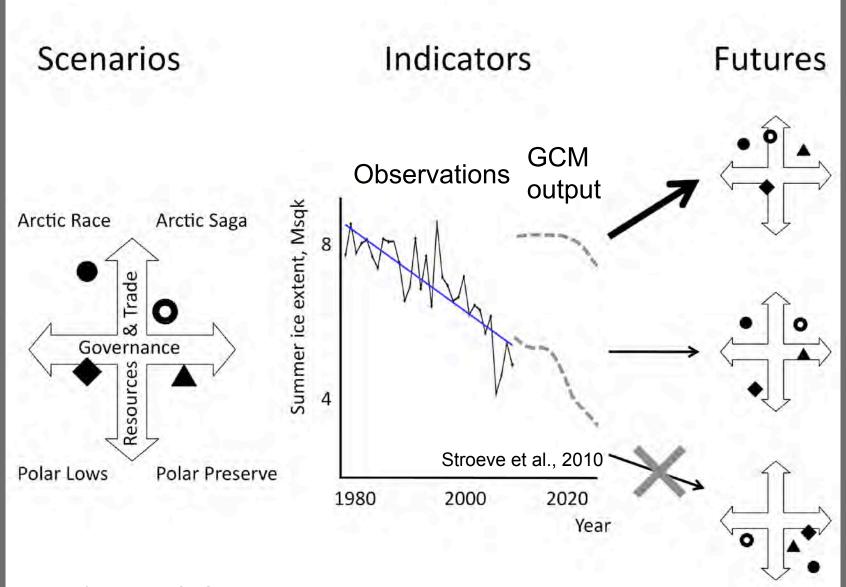
- Herman Kahn (1950/60s): The unthinkable
- Royal Dutch Shell (1970-): Oil crisis of 1973 & rise of Russia as natural gas supplier
- Scenarios as a planning & strategy tool in the business sector 1980s to today
- Scenarios as a tool in sustainability & resilience science

## Steps in scenario identification

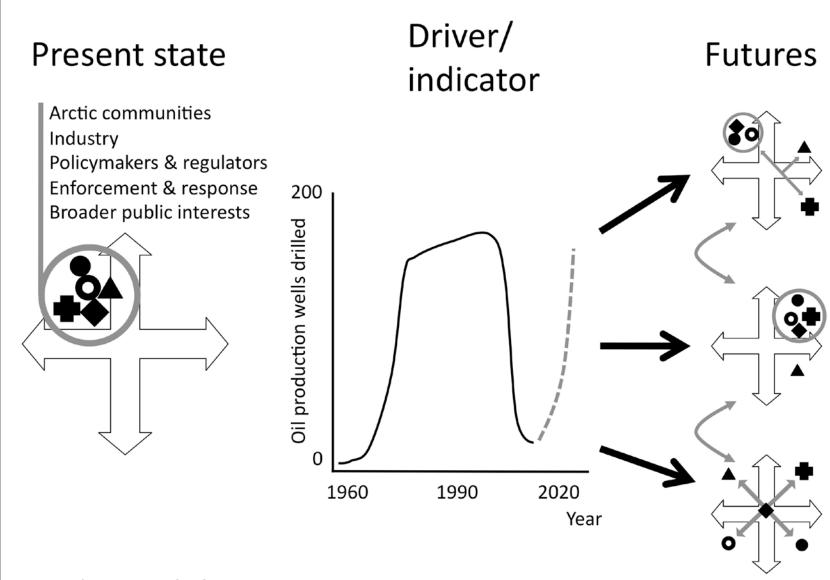
- Co-develop defining question
- Summarize current knowledge & trends
- Identify important drivers (factors, forces)
- Identify key uncertainties (from key drivers)
- Develop scenarios as plausible futures for bundles of key drivers & uncertainties
- Identify indicator variables
- Integrate scenarios into planning process by tracking indicators & developing strategies cognizant of scenarios



## Decision-making in a changing Arctic



## Decision-making in a changing Arctic



Eicken & Lovecraft, Ch. 9, Nx2020, 2011

 Which variables or key factors do we need to track?

Logal	Arctic	Status	Tense	Armed	
Legal Frame-	Treaty	Quo	Relation-	Conflict	
work	System	1 11	ships		
Global	Low	Moderate	High	Industrial	Collapse
Trade	Growth	Growth	Growth	Explosion	of Global
<b>Dynamics</b>					Economy
Climate	New	Ice Free -	Seasonal	Seasonal	New
	Cretate-	Severe	Ice	lce –	Ice Age
	ous Period	Weather	Shippable	Dangerous	
Safety of	Increasing		Stable		
Other	Pressure	crease of	Demand		
Routes		Traffic			
	Worldwide		Gain &		
Impact of		Loss &	Coopera-		
Climate	Conflict	Conflict	tion		
Oil Prices	Unpre-	Steady	Stable	Cheap	
	dictable	Rise, Pre-		Oil	
NA-: A	Oscillation		Maxima	No	
Maj. Arctic		Moderate	Maximum Impact	No Disaster –	
Shipping Disasters	Impact	Impact	Прасс	No impact	
Windows	Limited	Modarata	No Limit	110 impact	
of	Limited	Moderate	NO LIMIT		
Operation					
Maritime	Refusal	Partial	Drive		
Insurance	iterusar	raitiai	Improve-		
Industry			ments		
Asian	Coopera-	Collabora-	No Market		
Players	tion	tion	Entry		
			1		
		11.1			
Transit	Economic.	Robbery			
Transit Fees	Viable	Robbery Knights			
Fees					
Fees Indig. vs.	Viable Fees Wealth –	Knights Wealth –	No Inter-	Inter-	
Fees Indig. vs. Commerc.	Viable Fees Wealth – Low Inter-	Knights  Wealth – trad. life-	ference -	ference -	
Fees Indig. vs. Commerc. Conflict	Viable Fees Wealth – Low Inter- ference	Wealth – trad. life- style loss	ference – No Profit	ference – Conflict	
Fees Indig. vs. Commerc. Conflict Arctic	Viable Fees Wealth – Low Inter- ference Multilat.	Wealth – trad. life- style loss Multilat.	ference – No Profit Unilateral	ference – Conflict Conflicts	Arctic
Fees Indig. vs. Commerc. Conflict	Viable Fees Wealth – Low Inter- ference Multilat. Military	Wealth – trad. life- style loss Multilat. Police	ference – No Profit Unilateral Territorial	ference – Conflict Conflicts Between	Arctic Privateers
Fees Indig. vs. Commerc. Conflict Arctic Enforcers	Viable Fees Wealth – Low Inter- ference Multilat. Military Force	Wealth – trad. life- style loss Multilat. Police Force	ference – No Profit Unilateral Territorial Protection	ference – Conflict Conflicts Between Enforcers	
Fees Indig. vs. Commerc. Conflict Arctic Enforcers	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear	Wealth – trad. life- style loss Multilat. Police	ference – No Profit Unilateral Territorial Protection Hydrogen	ference— Conflict Conflicts Between Enforcers Fossil	
Fees Indig. vs. Commerc. Conflict Arctic Enforcers	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear Propul-	Wealth – trad. life- style loss Multilat. Police Force	ference – No Profit Unilateral Territorial Protection Hydrogen Based	ference – Conflict Conflicts Between Enforcers	
Fees Indig. vs. Commerc. Conflict Arctic Enforcers Propulsion Energy	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear Propul- sion	Wealth – trad. life- style loss Multilat. Police Force SkySails	ference – No Profit Unilateral Territorial Protection Hydrogen	ference— Conflict Conflicts Between Enforcers Fossil	
Fees Indig. vs. Commerc. Conflict Arctic Enforcers Propulsion Energy New	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic	Wealth – trad. life- style loss Multilat. Police Force SkySails	ference – No Profit Unilateral Territorial Protection Hydrogen Based	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers Propulsion Energy New Resource	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear Propul- sion	Wealth – trad. life- style loss Multilat. Police Force SkySails	ference – No Profit Unilateral Territorial Protection Hydrogen Based	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers Propulsion Energy New Resource Discovery	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn.	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers Propulsion Energy New Resource	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush Little	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn.	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn.	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear Propul- sion Arctic Gold Rush Little Change	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush Little	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Fees Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns Regulation	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear Propul- sion Arctic Gold Rush Little Change	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns Regulation in the	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush Little Change Do As You Wish	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns Regulation in the Arctic Thermo- haline Circ	Viable Fees Wealth – Low Inter- ference Multilat. Military Force Nuclear Propul- sion Arctic Gold Rush Little Change	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns Regulation in the Arctic Thermo- haline Circ Weakens	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush Little Change Do As You Wish	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns Regulation in the Arctic Thermo- haline Circ. Weakens Hot	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush Little Change Do As You Wish Wild Card	Wealth – trad. life-style loss Multilat. Police Force SkySails Weak Demand/Restrictions Moderate Change Moderate Regulation No Wild Card	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	
Indig. vs. Commerc. Conflict Arctic Enforcers  Propulsion Energy  New Resource Discovery World Trade Patterns Regulation in the Arctic Thermo- haline Circ Weakens	Viable Fees Wealth – Low Interference Multilat. Military Force Nuclear Propulsion Arctic Gold Rush Little Change Do As You Wish	Wealth – trad. life- style loss Multilat. Police Force SkySails Weak De- mand/Re- strictions Moderate Change Moderate Regulation No Wild Card	ference – No Profit Unilateral Territorial Protection Hydrogen Based Propulsn. Strong Change	ference— Conflict Conflicts Between Enforcers Fossil	

# Key factors: consistency analysis

- Advanced scenario analysis to assess consistency of different scenarios and identify key variables to be tracked (Mueller-Stoffels & Eicken, Nx2020 volume, Chapter 6.7)
- Querying of experts through online tools, with evaluation of a consistency/ plausibility matrix of high order

Figure 6.7.2. Robust development in the Arctic raw scenarios. Red: overall most robust bundle without wild card; green: high robustness, consistency, and plausibility; magenta dashed: overall most robust with wild card; yellow dashed: robust and plausible.

Legal Frame- work	Arctic Treaty System	Status Quo	Tense Relation- ships	Armed Conflict	
Global Trade Dynamics	Low Growth	Moderate Growth	High Growth	Industrial Explosion	
Climate	New Cretate- ous Period	Ice Free - Severe Weather	Ice	Seasonal Ice – Dangerous	New Ice Age
Safety of Other Routes	Increasing Pressure	Stable In- crease of Traffic	Stable Demand		
SocEcon Impact of Climate	Worldwide Loss & Conflict	Regional Loss & Conflict	Gain & Coopera- tion		
Oil Prices	Unpredictable Oscillation	Steady Rise, Pre- dictable	Stable	Cheap Oil	

 Advanced scenario analysis to assess consistency of different scenarios and identify key variables to be tracked

## Scenarios as a tool for synthesis & action

- Bodies of knowledge
  - Scientific
  - Practical
  - Local
  - Indigenous
- Holders of knowledge
  - Communities & practicioners
  - Repositories & archives
  - Institutions & frameworks

- Action: Response to Arctic change
  - Passive system response
  - Active response through adaptation, mitigation, negation, etc.
- Scales of action
  - Local
  - Regional
  - National
  - Global