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Severe Accidents in the Energy Sector Triggered by Natural Events

Peter Burgherr & Petrissa Eckle

Outline

ENergy related Severe Accident Database (ENSAD)

Analysis of accident data from ENSAD –
Focus on FATAL accidents in particular severe accidents with ≥ 5 fatalities

Historical data on accidents triggered by natural events compared to other accidents

Severe Accidents Database ENSAD

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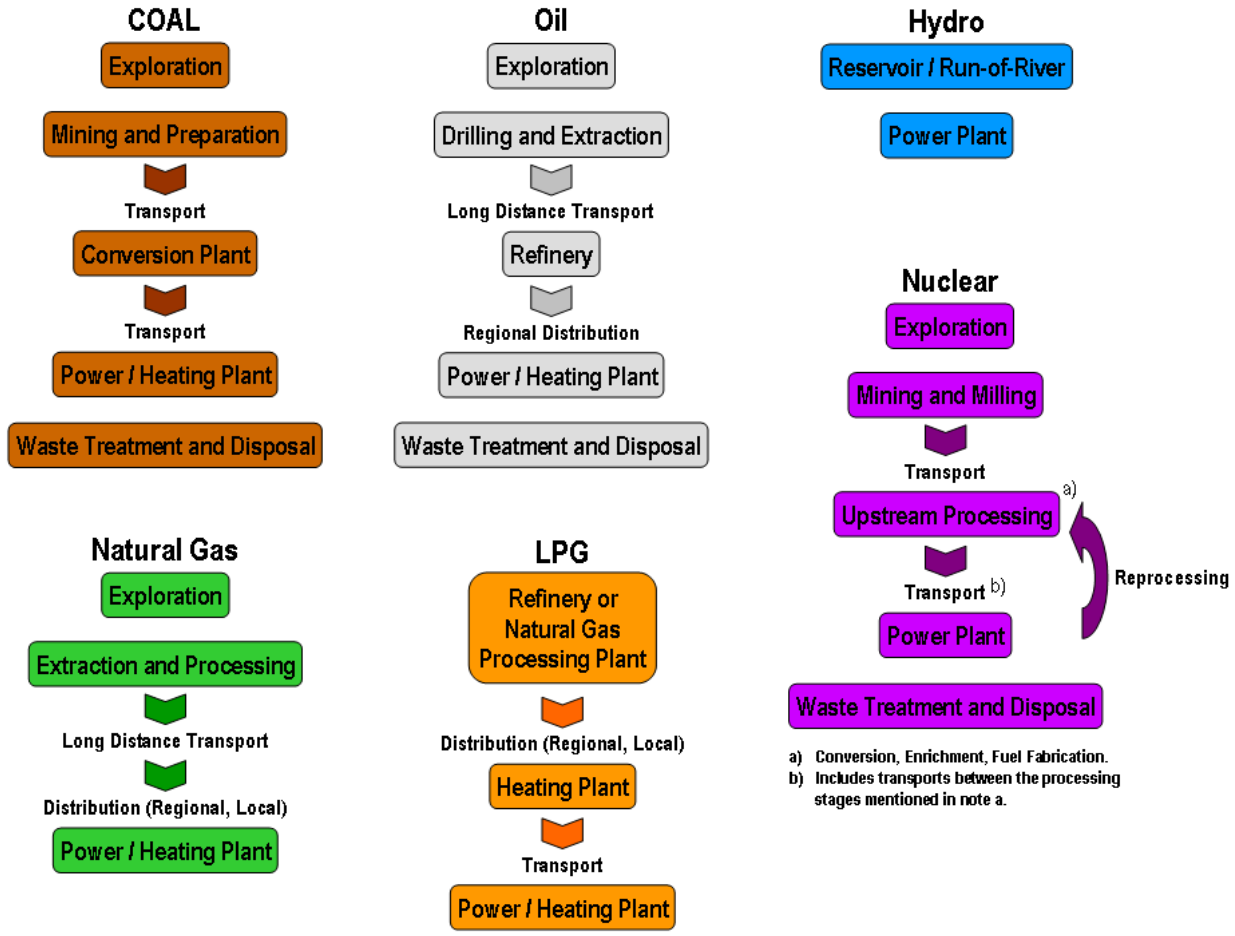

Severe Accidents Database ENSAD

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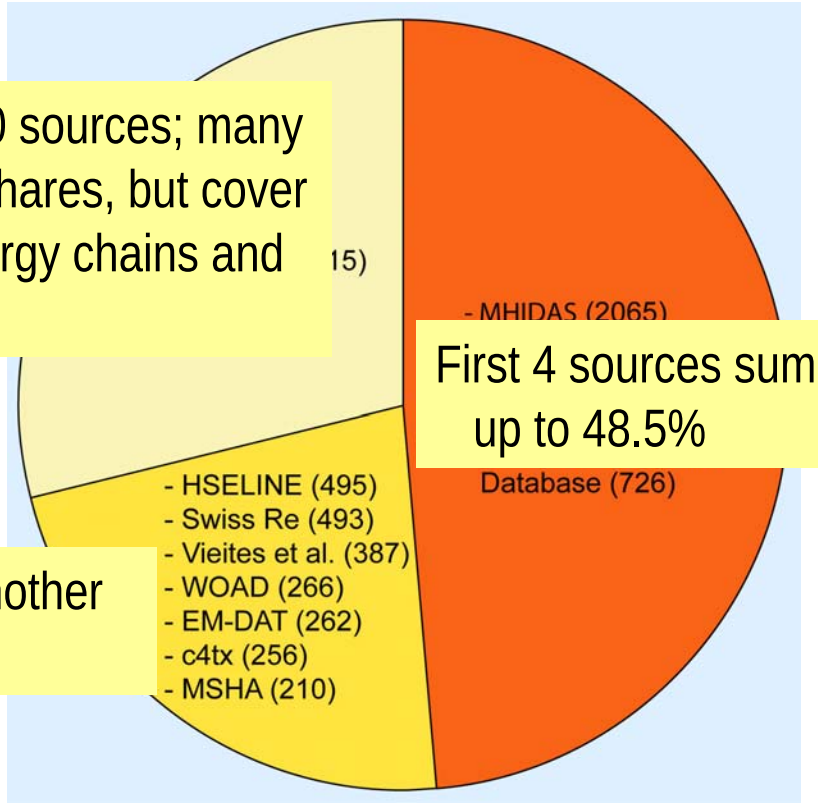
Comprehensive global database of energy related severe accidents : ENSAD

- Full energy chains – from exploration – resource extraction--- transport and power plant
- Updating from a variety of sources



Another 170 sources; many with small shares, but cover specific energy chains and or countries

First 4 sources sum up to 48.5%

Next 7 sources for another 22.6%

Burgherr & Hirschberg, 2008

Severe Accidents Database ENSAD

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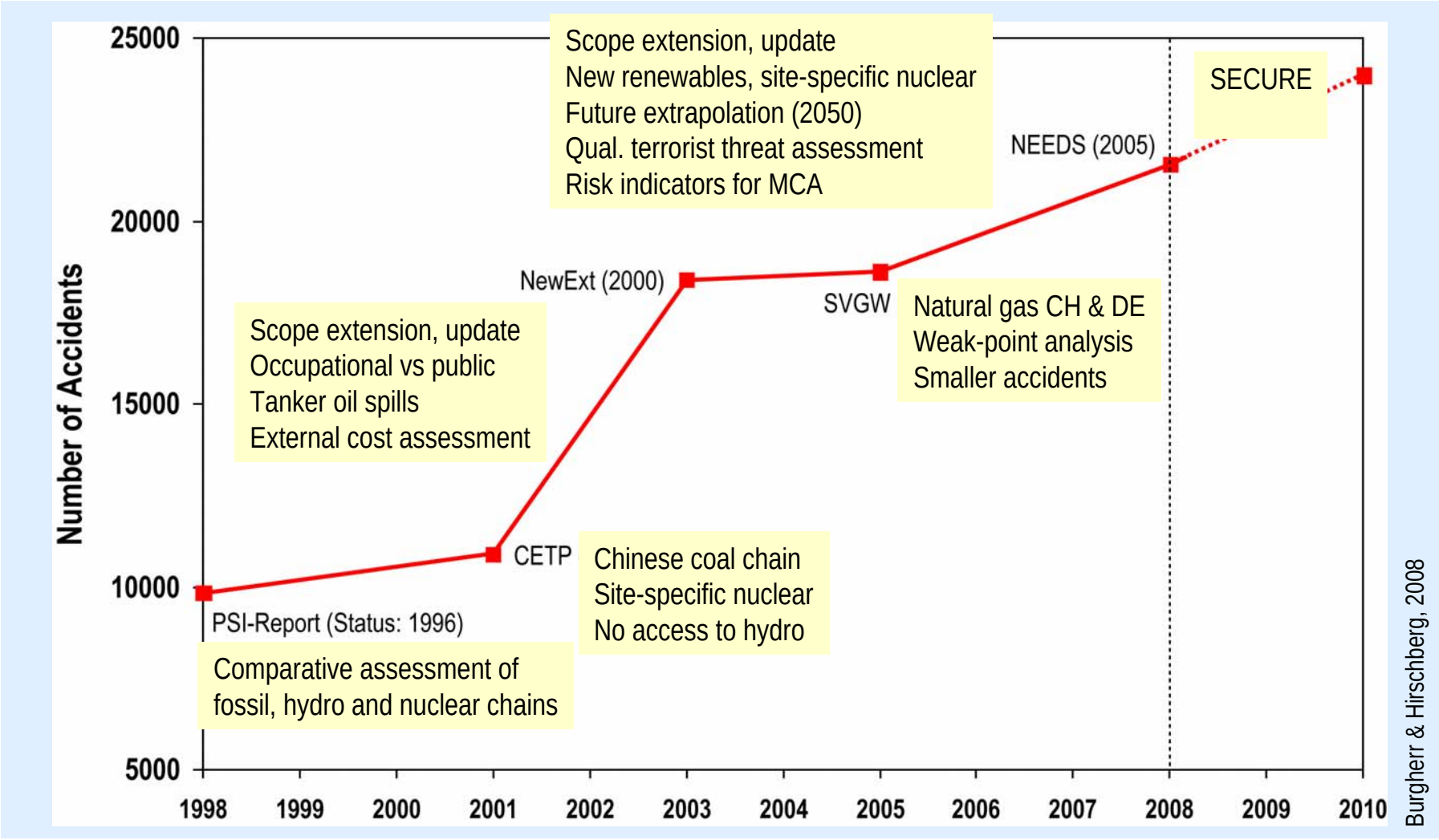
Comprehensive global database of energy related severe accidents : ENSAD

- Full energy chains – from exploration – resource extraction--- transport and power plant
- Updating from a variety of sources
- ENSAD definition of severe accidents: **≥5 fatalities**, ≥10 injured, ≥5 mio.$ etc.

Consequence indicator	ENSAD	Sigma	EM-DAT	NatCat	WOAD
Fatalities	≥ 5	≥ 20 (dead or missing)	≥ 10	> 20	≥ 1
Injured persons	≥ 10	≥ 50	aff.	-	-
Evacuees	≥ 200	≥ 2000 (homeless)	aff.	-	-
Extensive ban on consumption of food	yes	-	-	-	-
Release of hydrocarbons	≥ 10000 t	-	-	-	≥ 1000 t
Enforced clean up of land and water area	≥ 25 km^2	-	-	-	-
Economic loss	≥ 5 million USD(2000)	≥ 82.2 million USD(2007)	-	> 50 million USD (2007)	-

Major Steps in ENSAD Development



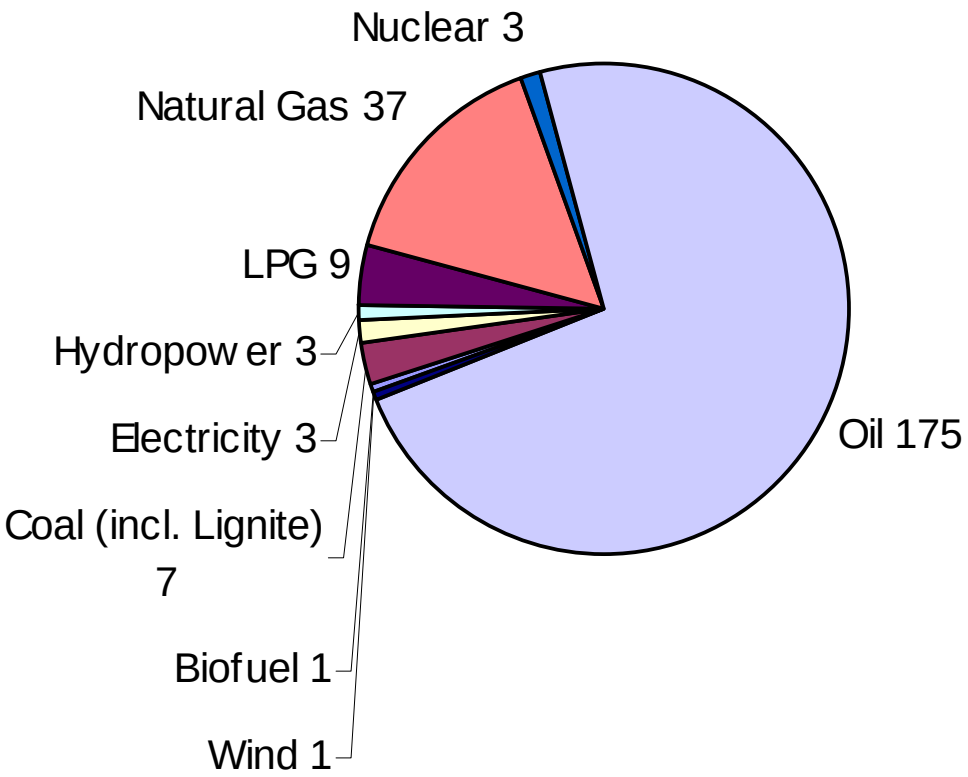
Goals..

Compare the risks in the different energy chains

- What is the average frequency of accidents and average consequences in the different energy chains?
- What is the potential for catastrophic accidents?
- Are there trends over time? Is energy production getting safer?
- Can we see regional differences in the risk?
- How many accidents are we responsible for due to energy imports?
- Accident triggers?

Accidents caused by natural causes

Accidents from 1970-2008 : ENSAD 239 in total



Oil Tanker Spills Triggered by Natural Events

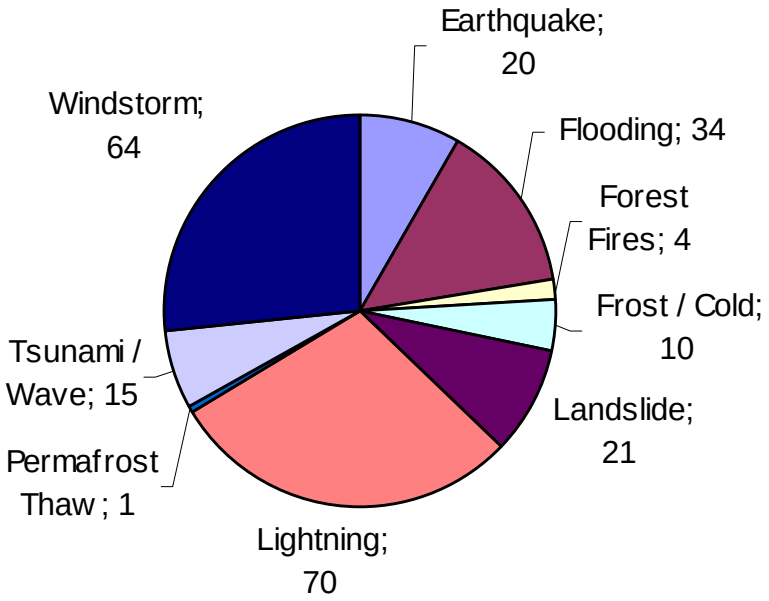
Major Tanker Oil Spills of at least 1000 tonnes (from ENSAD, all)

Year	Tanker Name	Location	Trigger	Spill Amount [tonnes]
2002	Prestige	Cap Finisterre, Galicia, Spain	Heavy seas	63'000
1994	Thanassis A	700 km off Hong Kong, South China Sea	Typhoon Teresa	36'800
1983	PNOC Basilan	Off Agoo (Luzon, Philipinnes), South China Sea	Huge waves	17'050
1979	SS Chevron Hawaii	Deer Park, Texas, USA	Lightning	7950
1995	Sea Prince	Near Yosu, off Sori Island, South Korea	Typhoon Faye	5000
1981	Hakuyoh Maru	Genoa, Liguria, Italy	Lightning	3000
1975	Kriti Sun	Esso SBM, off Jurong, Singapore	Lightning	3000
2007	Volgoneft 139	Off Port Kavkaz, Kerch Strait	Severe storm	3190
2001	Zainab	Near Dubai's Jebel Ali por	Strong wave	1300

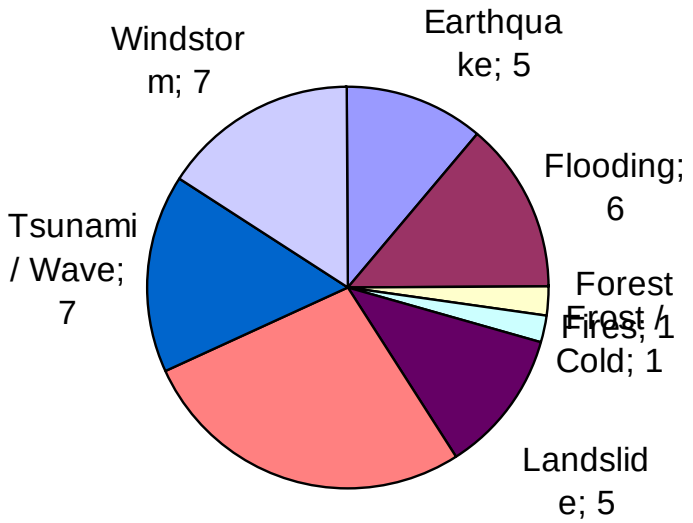
Source: ENSAD Database

Events caused by natural triggers

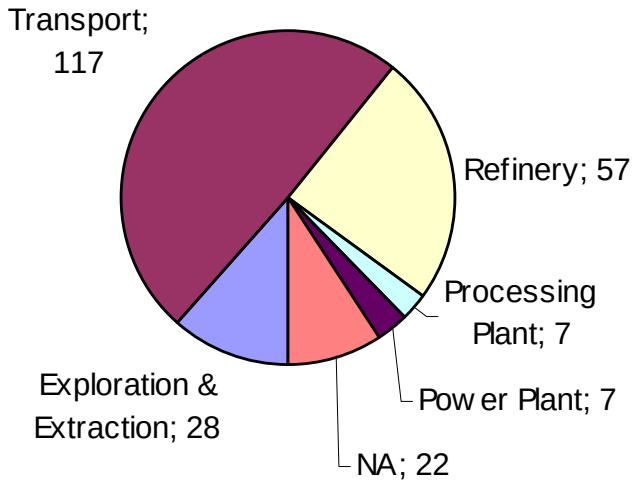
Triggers all accidents



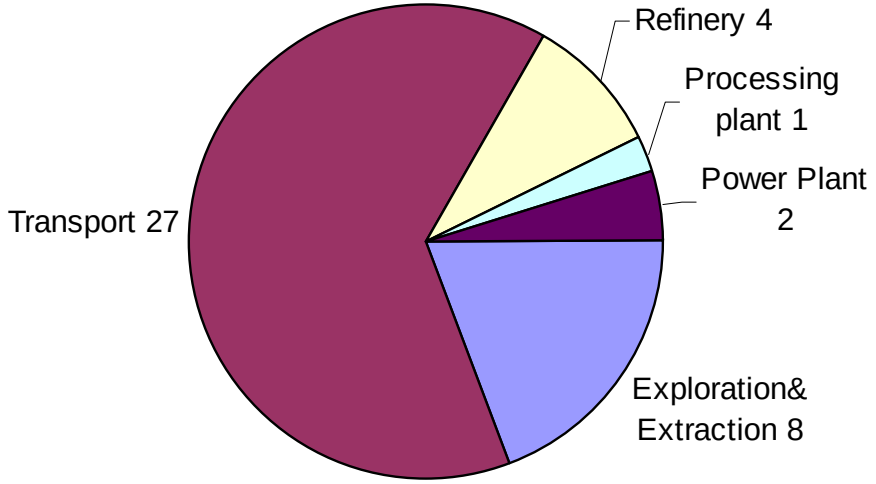
Triggers fatal accidents



Accidents by chain stage



Fatal accidents by chain stage



Impacts of Hurricanes Katrina & Rita (2005)

Platforms and Rigs

	Based on MMS statistics		Based on ENSAD
	Katrina	Rita	
Platforms evacuated	645	482	Only summary data, no actual count
Platforms destroyed	46	65	Only one reported by name and location
Platforms extensive damage	20	32	Only two reported by name and location
Rigs evacuated	79	137	Only summary data, no actual count
Rigs destroyed	1	4	No specific information
Rigs extensive damage	4	9	No specific information
Rigs adrift	5	6	Only five reported by name and location

- Reports on platforms and rigs impacted by hurricanes are only sparsely available in ENSAD because these events are generally not reported in a location-specific and detailed manner in most of the primary information sources. Thus additional sources such as official statistics and reports as well as case studies need to be consulted.

Impacts of Hurricanes Katrina & Rita (2005)

Major Oil Spills of at least 10'000 gallons (32.5 tonnes)

Facility Owner	Location	Affected Infrastructure	Spill Amount [t]
Bass Enterprises	Cox Bay, Louisiana	Storage depot	12'285
Shell	Pilottown, Louisiana	Storage tank	3413
Chevron	Empire, Mississippi	Storage tank	3221
Murphy Oil	Meraux, Louisiana	Storage tank	2662
Bass Enterprises	Point a la Hache, Louisiana	Storage tank	1498
Chevron	Point Fourchon, Louisiana	Storage tank	172
NA	Hackberry, Louisiana	Storage tank	104
Venice Energy Services	Vencie, Louisiana	Storage tank	81
Shell Pipeline Oil	Nairn, Louisiana	Pipeline	44
Sundown Energy	West Potash, Louisiana	Pipeline	42

Source: ENSAD Database

-> ENSAD covers large spills from hurricanes

Fatal / severe accidents, share of natural triggers

	FATAL / SEVERE ACCIDENTS worldwide 1970-2008		
	all	Natural Trigger	Share in %
Oil	1340 / 530	29 / 19	2 / 4
Natural Gas	556 / 186	5 / 3	1 / 2
Coal (without China)	609 / 249	5 / 5	1 / 2
Hydro Power	18 / 13	1 / 1	6 / 8

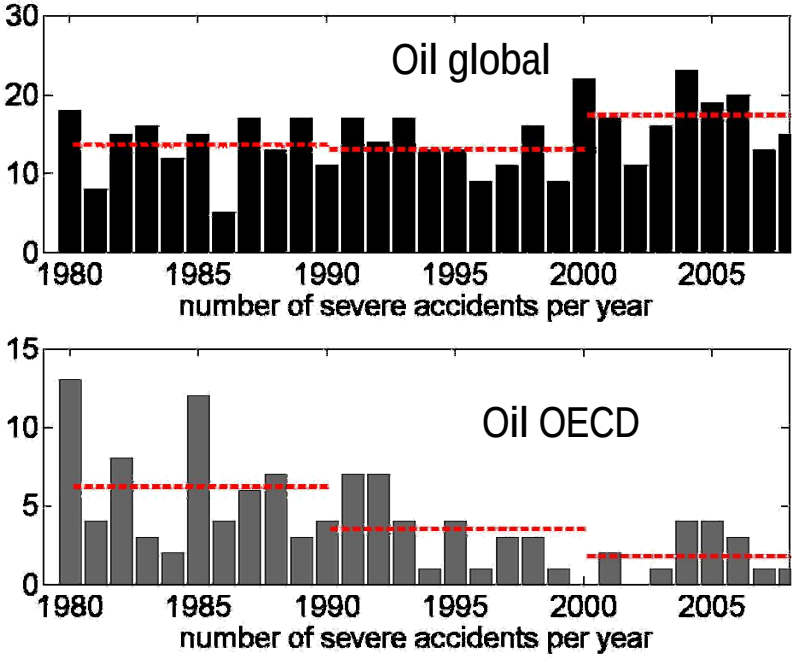
Most severe

26 000 fatalities:	Hydropower dam broke in floods, China, 1975
580 fatalities:	Lightning struck a complex of 8 fuel tanks, flaming fuel spread through town, Egypt, 1994
91 fatalities:	Sinking of drilling ship, storm, Thailand, 1989
74 fatalities:	Flooding of mines by river, India, 1995
37 fatalities:	Earthquake caused explosion at refinery , Turkey, 1999

Severity?

Frequency

Number of accidents per year
(possibly per unit of energy)

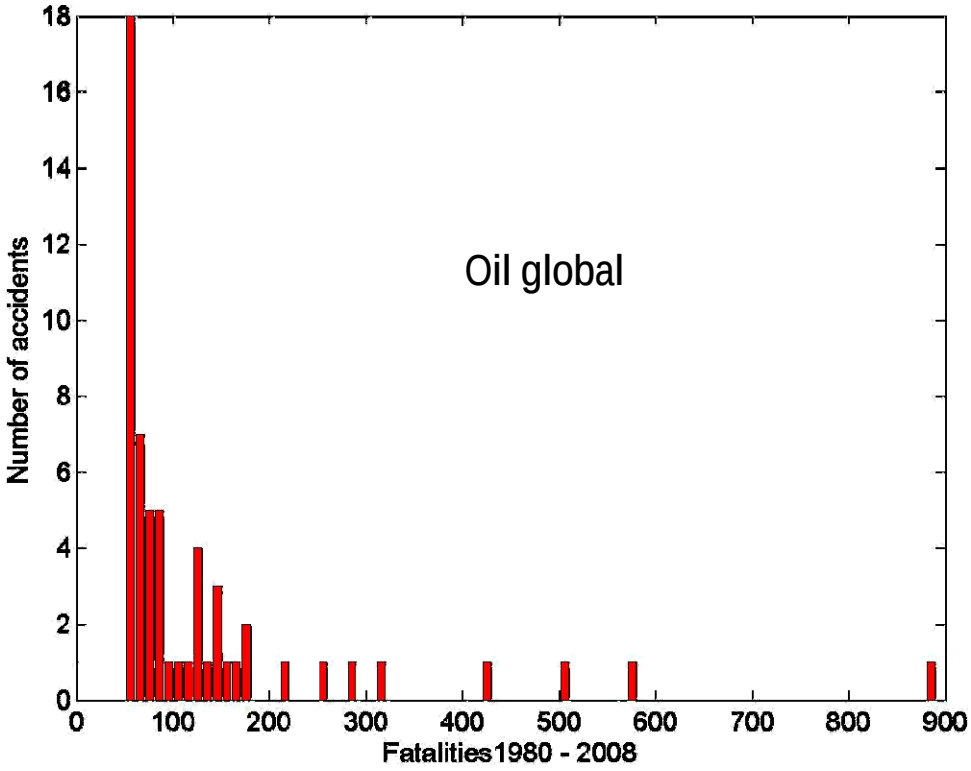


Small variance

- Average frequency
- Determine trends in time

x Severity

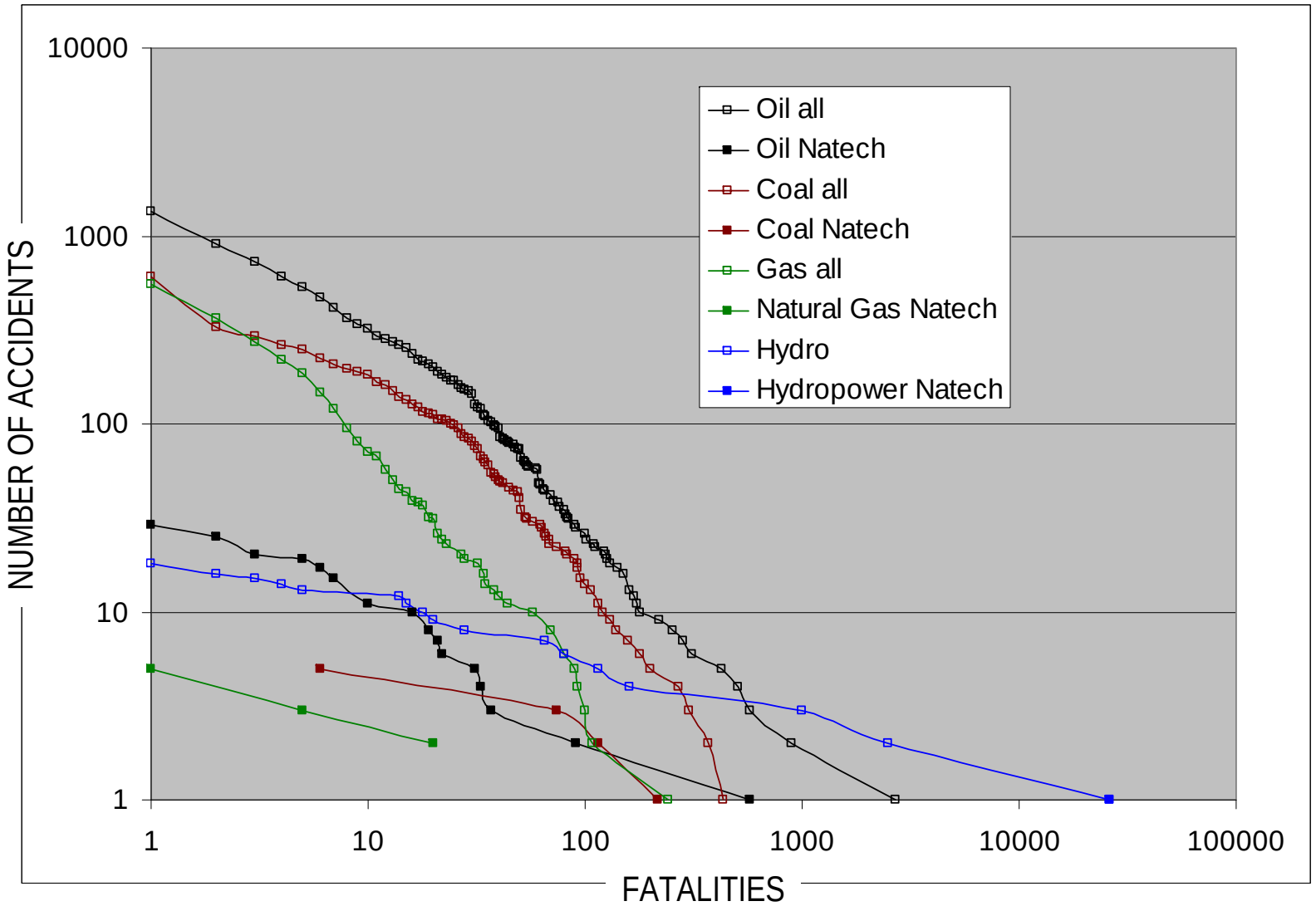
number of fatalities per accident



- Very broad distribution (fat tailed, Power law distribution such as Pareto) -> no averaging
- Trends in time very hard to detect!

Natech vs. all fatal accidents FN curves

Number of accidents that exceed N fatalities 1970-2008



Summary and outlook

Analysis of accident risk for severe accidents (≥5 fatalities) based on ENSAD data
Separate analysis of frequency and severity

Accidents with natural triggers:

Few data points
- reasonable idea about historical frequency
- severity needs to be analyzed in more detail, are differences with other triggers to be expected?

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Thank you for your attention