Superfund – system for cleaning contaminated sites
超级基金—污染场地治理体系

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Tongling training workshop, May 28-29, 2014

铜陵培训班，5月28日-5月29日，2014年

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- Love Canal and Times Beach

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- Superfund – An overview

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Love Canal 拉夫运河

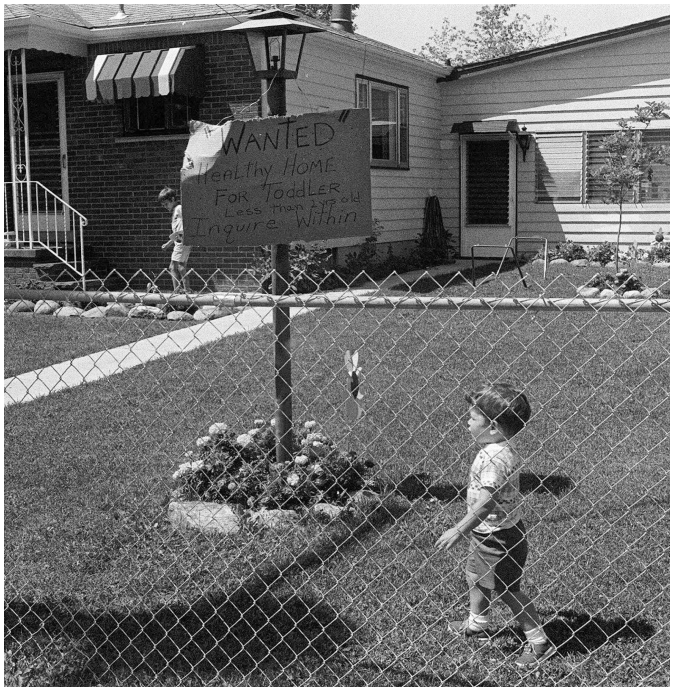
- Love Canal was a village and abandoned canal close to Niagara Falls, USA
- 拉夫运河是美国尼亚加拉大瀑布附近的村镇中一条被遗弃的运河。
- In 1942 a company called Hooker Chemical Company was given permission to dump chemical waste in the canal. 21,000 tons of chemicals were dumped over the next ten years.
- 1942年胡克化学公司获得了向运河中倾倒化学废物的许可。在随后的10年中约有2.1万吨化学品被倾倒入运河中。

The ground was then sold to build a school for one dollar. (At the insistence of the School Board!)
场地随后以1美元的价格出售建设学校（在校委员会的强烈要求下）

VISTA ANALYSE

Love Canal
拉夫运河

- In the 1960's and 70's miscarriages, birth defects, leukemia etc started to arise. President Carter declared emergency.
- 20世纪60-70年代，流产、出生缺陷、白血病等开始出现。卡特总统宣布进入紧急状态。
- More than 800 homes were abandoned.
- 超过800户住宅被遗弃。
- Today buildings have been taken down, only the old streets remain.
- 如今建筑已被拆除，只有街道留存。
- The most toxic area (about 100 mu) is reburied with thick plastic liner, clay and dirt. A 2.4 m high barbed wire fence has been installed.
- 毒性最大的区域（大约100亩）已用厚塑料衬里、粘土和污泥填埋，安装了2.4米高铁丝网栅栏。



VISTA ANALYSE

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Times Beach 时代海滩

- Times Beach is an abandoned town in Missouri, USA
- 时代海滩是美国密苏里州一个荒弃的城镇。
- In beginning 1970 the town still had many dirt roads (without asphalt). It hired a man called Bliss to spray the roads with oil.
- At the same time Mr. Bliss had a contract to dispose of chemical waste from a company. He mixed the chemicals into the oil.
- In 1982 EPA visited and took soil samples. Later that year the town flooded. 95% of the town was covered with 3 m or more of water.
- In December EPA announced dangerous levels of dioxin in the soil.

1970年代初该镇还有很多未铺沥青的土路。Bliss受雇将道路洒上油。同时他与某家公司签有处置化学废弃物的合同。于是他将化学品混入了油中。

1982年EPA对道路采集土样，当年该镇遭受了洪灾，95%的城镇被3米以上的水淹没。12月EPA宣布土壤中的二噁英达到危险等级。

Times Beach 时代海滩

- In February 1983 EPA bought the whole town.
- A designated incinerator was built to burn the soil from Times Beach and 28 other sites in Missouri. Afterwards it was dismantled and the site handed over to the State.
- The land is now a State Park.
- The EPA revisited the site in 2012 and declared it safe.

1983年2月，EPA买下了整座城镇，并设计建造了一座焚烧炉，用于焚烧时代海滩和密苏里州其它28个污染场地的污染土。此后，焚烧炉被拆除，场地转移至州所属。
该场地现在是个州立公园。EPA于2012年对场地进行了重新评估，并宣布其为安全区域。

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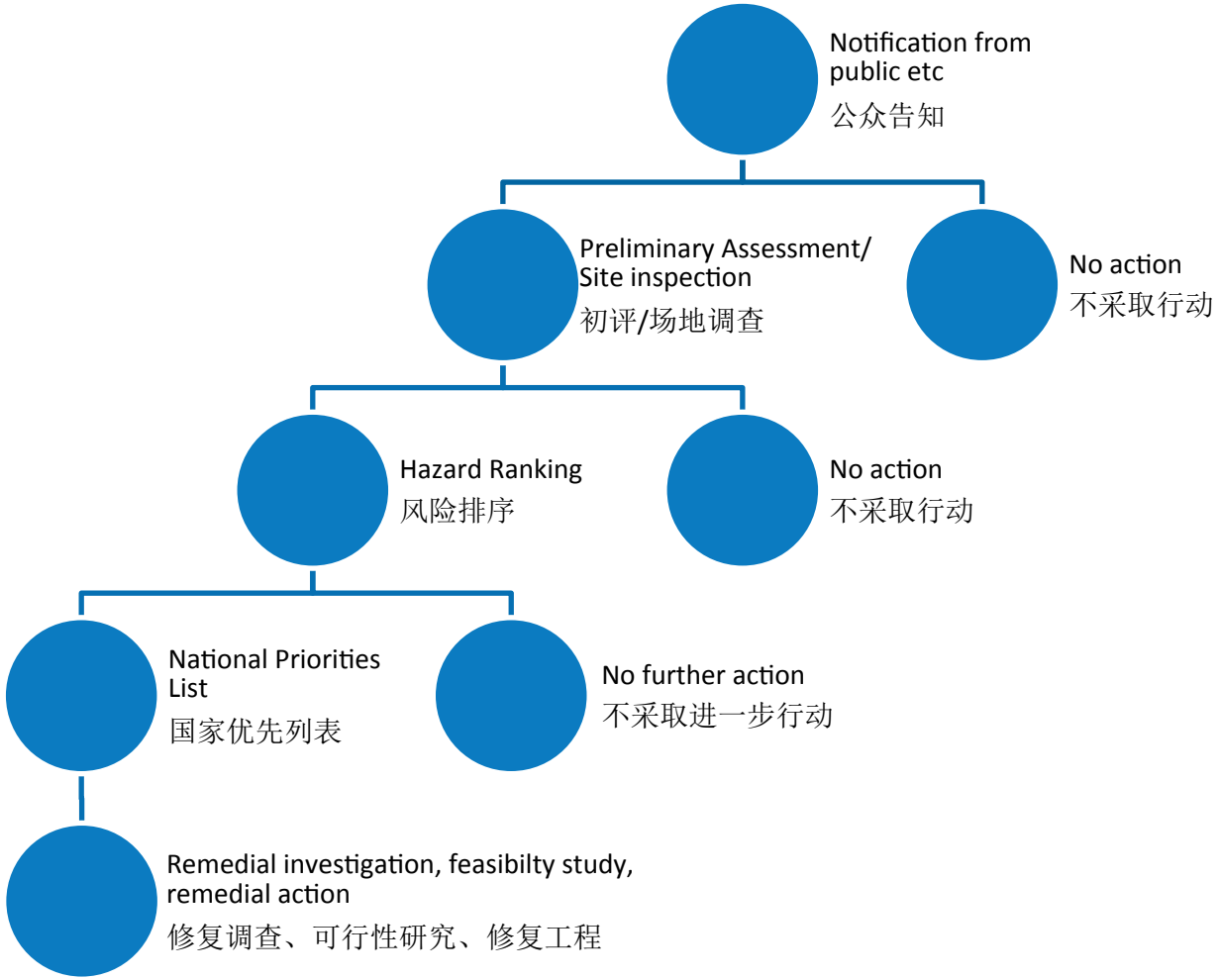
Superfund 超级基金

- Love Canal, Times Beach and other incidents lead to
- The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – known as **Superfund**
- 拉夫运河、时代海滩及其它事件直接导致美国《综合性环境反应、补偿以及责任法》的出台，即超级基金
- Objectives:
- Prevent harm from hazardous waste
- Pass the burden of cleanup to original producers

- 目标：防止危险废物损害，将清理污染的责任转移给原生产商

The Superfund system
超级基金体系



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National Priorities list is the key
核心：国家优先列表

- The National Priorities List (NPL) is the core list of sites to be watched and regulated
- Determines which sites warrant further investigation to assess nature and extent of environmental risk («whether to do something»)
- 国家优先列表NPL包括监控管理的核心场地，决定了哪些场地需要进一步调查，以判断环境风险的属性和范围（是否需要采取行动）
- Identify what remedial action that is appropriate («what to do»)
- Notify the public which sites EPA believes should have further investigation
- Notify potentially responsible party (PRP) that EPA may initiate action (and the PRP must pay)
- 判断修复行动的适用性（采取什么行动）；告知公众EPA认定下一步调查的场地；告知潜在责任方（PRP）EPA可能采取初步行动（PRP付费）
- Currently 1313 sites listed
  - Construction completed on 1156 sites
- 目前已列有1313个场地，其中1156块场地施工完成。

How to get on the National Priorities List
加入国家优先列表方法

- *Site discovery:* Notification to EPA by cities, state agencies, EPA regional offices. Site discovery may lead to preliminary assessment
- 发现场地：由市、州机构和EPA区域办公室告知EPA。发现场地后可能采取初步评估。
- *Preliminary assessment*: Assessment of readily available information about a site and its surrounding area. If the preliminary assessment results in a recommendation for further investigation, a *Site investigation* is performed. Placement on National Priorities List is now likely
- 初步评估：对场地和周边区域现有信息进行初步评估。如果结果表明需要进行进一步调查，则开展场地调查工作，并可能进入国家优先列表。
- *Site investigation*: Investigators collect environmental and waste samples. Determine if substances are released and assess if they have reached nearby locations. Provides information for next step.
- 场地调查：调查者对环境和废弃物采样。判断是否有污染物释放，并评估污染是否扩散。为下一步工作提供信息。

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The Hazard Ranking System
风险排序系统

- Sites subject to Preliminary Assessment and Site Inspection are *candidates* for the National Priorities List
- The next step is the Hazard Ranking System
- 进行初步评估和场地调查的场地作为国家优先列表的候选场地。下一步即为风险排序系统HRS。
- A numerically based screening system that evaluates the potential of sites to pose a threat to human health or the environment.
- The system assigns numerical values to factors that determine risk at a site.
- HRS是用于评估场地对人体健康和环境的潜在风险的定量筛选系统，通过对场地参数赋值来判断风险大小。

The Hazard Ranking System
风险排序系统

- **The system assigns numerical values to factors that determine risk at a site.**
- 系统对场地参数赋值以判断风险大小。
- **Three categories –**
  - Likelihood that a site has released or has potential to release hazardous substances to environment
  - Toxicity, waste quantity and other characteristics of the waste
  - People or sensitive environments affected by the release
- 包括三类—
  - 场地很可能释放危险物质，或具有释放危险物质的潜在可能性的；
  - 毒性、废物量和其它废物属性；
  - 受泄漏影响的人群或环境敏感受体。
- **Note the structure: «Likelihood times consequence»**
  - Toxicity etc: Consequence 1
  - People: Consequence 2
- 构成：可能性 * 后果——毒性：后果1；人群：后果2

Four pathways in Hazard Ranking System
风险排序系统中的四类途径

- Four pathways – 四类途径包括：
- Ground water 地下水
- Surface water 地表水
- Soil 土壤
- Air 空气

- Scores are calculated for each pathway
- Combined score («quickscore»)
- 将各类途径加总得到总分（快速打分法）：

$$S = \sqrt{\sum S_i^2}$$

- Site included in National Priorities List if S > 28.5 !!
- 如果S>28.5分则场地被纳入NPL中

Site Name: LPQ Auto Parts

City, County, State: Pike County OH

EPA ID#: XXY987654321

Lat/Long: 39 07 53" N / 83 01 53" W

Congressional District:

This Scoresheet is For: SI

Scenario Name: Training Session

Description: Pre-entered dat used for training.

Region: 5

Evaluator: Student

Date: 10/23/1998

T/R/S:

俄亥俄州派克郡LPQ汽车零件场地案例

		S^2途径 S^2 pathway	S^2途径 S^2 pathway
地下水	Ground Water Migration Pathway Score (S_{gw})	100	10000
地表水	Surface Water Migration Pathway Score (S_{sw})	100	10000
土壤暴露	Soil Exposure Pathway Score (S_s)	23.68	560.7424
空气扩散	Air Migration Score (S_a)	4.08824242424242	16.7137261193755
	$S^2_{gw} + S^2_{sw} + S^2_s + S^2_a$		20577.4561
	$(S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4$		5144.364025
	$\sqrt{(S^2_{gw} + S^2_{sw} + S^2_s + S^2_a)/4}$		71.72

* Pathways not assigned a score (explain):

TABLE 3-1 —GROUND WATER MIGRATION PATHWAY SCORESHEET

Factor Categories and Factors	Maximum Value	Value Assigned	
Aquifer Evaluated:			
Likelihood of Release to an Aquifer:			
1. Observed Release	550	550	
2. Potential to Release:			
2a. Containment	10	10	
2b. Net Precipitation	10	6	
2c. Depth to Aquifer	5	3	
2d. Travel Time	35	5	
2e. Potential to Release [lines 2a(2b + 2c + 2d)]	500	140	
3. Likelihood of Release (higher of lines 1 and 2e)	550		550
Waste Characteristics:			
4. Toxicity/Mobility	(a)	1000	
5. Hazardous Waste Quantity	(a)	10000	
6. Waste Characteristics	100		56
Targets:			
7. Nearest Well	(b)	50	
8. Population:			
8a. Level I Concentrations	(b)	420	
8b. Level II Concentrations	(b)	0	
8c. Potential Conamination	(b)	93	
8d. Population (lines 8a + 8b + 8c)	(b)	513	
9. Resources	5	5	
10. Wellhead Protection Area	20	0	
11. Targets (lines 7 + 8d + 9 + 10)	(b)		568
Ground Water Migration Score for an Aquifer:			
12. Aquifer Score [(lines 3 x 6 x 11)/82,5000][c]	100		100.00
Ground Water Migration Pathway Score:			
13. Pathway Score (S_{gw}), (highest value from line 12 for all aquifers evalueated)[c]	100		100.00

[a] Maximum value applies to waste characteristcs category
[b] Maximum value not applicable
[c] Do not round to nearest integer

Remedial Investigation/Feasibility Study
修复调查/可行性研究

- When a site is listed in the National Priorities List the next step is a remedial investigation/feasibility study.
- These phases:
- 场地列入NPL后，下一步即为进行修复调查.可行性研究，包括：
  - Scoping 范围界定
  - Site characterization 场地识别
  - Development and screening of alternatives 编制和筛选替代方案
  - Treatability investigation 可治理性调查
  - Detailed analysis 详细分析
- Various tools available, including the *Ecological Risk Assessment 8-step Process*
- 可用工具包括：生态风险评价8步过程

Record of decision and remedial action
决策记录和修复行动

- The Remedial Investigation/Feasibility Study informs the decision made about the site.
- The *Record of Decision* is a public document that explains which cleanup alternatives will be used.
- 修复调查/可行性研究为场地决策提供支持。决策记录对公众公开，说明采用的清除方案。
- Remedial Design gives technical spesifications for cleanup. Remedial Action follows, and is the actual construction and implementation.
- 修复设计为清除行动提供技术细节，是修复行动的依据，是实际的工程和实施方案。
- A site may be deleted from the National Priorities List once all response actions are complete and all cleanup goals have been achieved.
- 当所有的响应行动完成，且修复目标达到后，场地可以从NPL中清除。

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Priorities 优先度

- EPA: Scoring on the Hazard Ranking System do not determine the priority
  - Because the info collected for score is not sufficient to be certain
  - Because other sites have already come to the attention of the EPA
- EPA：风险排序系统打分并不决定优先度。
  - 打分信息的确定性并不充分；
  - 其它场地受到EPA关注较早。
- There is a tendency that the worst «sins» are discovered first. This gives an implicit order of priority
- “最坏的行径被最先发现”，决定了潜在的优先度

Priorities 优先度

- In the initial years of legislation the U.S. levied a special tax on the chemical and petroleum industries and put into a fund. This gave financial opportunity to prioritise the most important sites.
- 美国立法初期，设置了一种针对石油化工行业的特定税种，以建立基金，为保证最重要场地的优先权提供了财政基础。
- Now the tax is removed and the fund is depleted. The EPA must negotiate with potentially responsible parties about what action to take. The responsible party has to pay.
- 目前该税种已取消，资金面临缺口。由于潜在责任方需对治理行动付费，EPA必须与潜在责任方协商采取何种行动。
- Means that priorities are determined both by importance and by the financial strength of the responsible party.
- But in all likelihood the worst problems are discovered and solved. If a new Love Canal shows up it will clearly be a top national priority to solve.
- 意味着优先权由重要性和责任方的财政实力共同决定。
- 但仍然，最坏的问题被发现后最应当被解决。因此如果一个新的拉夫运河现在出现，它必然成为国家最优先问题被解决。

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Some lessons – principles and priorities 经验：原则和优先度

- Superfund contains an elaborate numerical scoring of environmental risk of a site
- 超级基金包括对场地环境风险进行详尽的量化打分。
- But no explicit evaluation of environmental risk versus cost
  - The principle is to demand remedial action when score > 28.5; The source of 28.5 as cut-off is not clear to us.
- 但是不包括环境风险与费用的外部评价：
  - 原则是当得分>28.5分时采取修复措施，但设定该值的原因不明
- The scores are not used to make priorities
  - Instead there seems to be a mix of environmental importance and financial considerations
  - But the most important problems are probably solved by now
- 分数不被用于确定优先权：
  - 而是综合考虑环境重要性和资金问题；但目前为止大部分最重要问题都可以被解决

Approach and tools 方法和工具

- In practice Superfund contains several levels of screening and assessment. Probably a good idea to copy
- 实际上超级基金包括筛选和评价的几个层次，值得借鉴。
- The hazard ranking system is elaborate. Worth studying
- 风险排序系统非常详细，值得学习。
- And is followed by the Remedial Investigation/Feasibility Study, which also contains elaborate methodology. Worth studying
- 随后进行修复调查/可行性研究，也包括一系列复杂详尽的方法，值得参考。
- Characteristics of the physical environment (land use, sensitivity of environment, population exposure) are taken into account when determining risk
- 物理环境特性（土地利用、环境敏感受体、人群暴露）在判定风险时很重要。

Relevance for China 中国相关…

- China is said to have 300,000 – 600,000 contaminated sites
- 据报道，中国拥有30万-60万污染场地
- Soil pollution plan released and soil pollution law in preparation
- 已颁布土壤污染防控规划，土壤保护法也正在筹备
- China could learn from Superfund the methodological approach to evaluating environmental risk and remedial actions to reduce risk
- 中国可以学习超级基金用于评价环境风险和用于降低风险的修复措施的技术方法。
- But the why priorities are set in the Superfund, including the disregard of cost and the need to negotiate with financiers is not impressive.
- 但超级基金中对成本的忽视，和与出资者协商的机制值得商榷

Thanks for Your Attention!

谢谢！