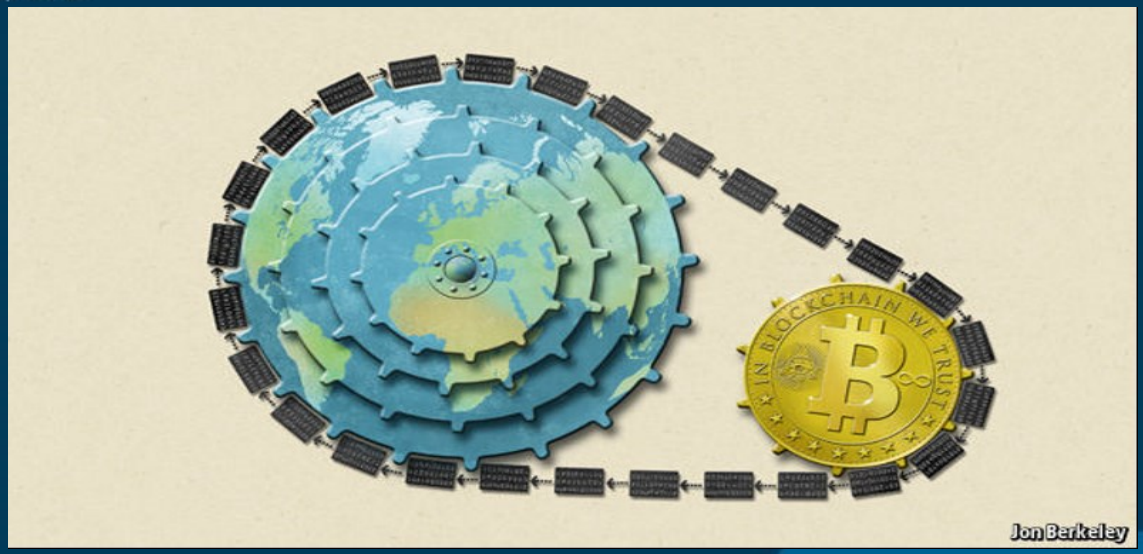
THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Blockchain-based Data Access Environment for Disaster Risk Reduction



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Blockchain-based data access for DRR - Agenda

- Why blockchain?
- The goal: better models for DRR – What if we could prepare better, respond better, build resilience communities in the face of growing threats?
- The urgency
- Blockchain connection to DRR
- What the future environment could look like – the data-sharing ecosystem
- Experimental first steps

Growing need for better models and techniques for DRR

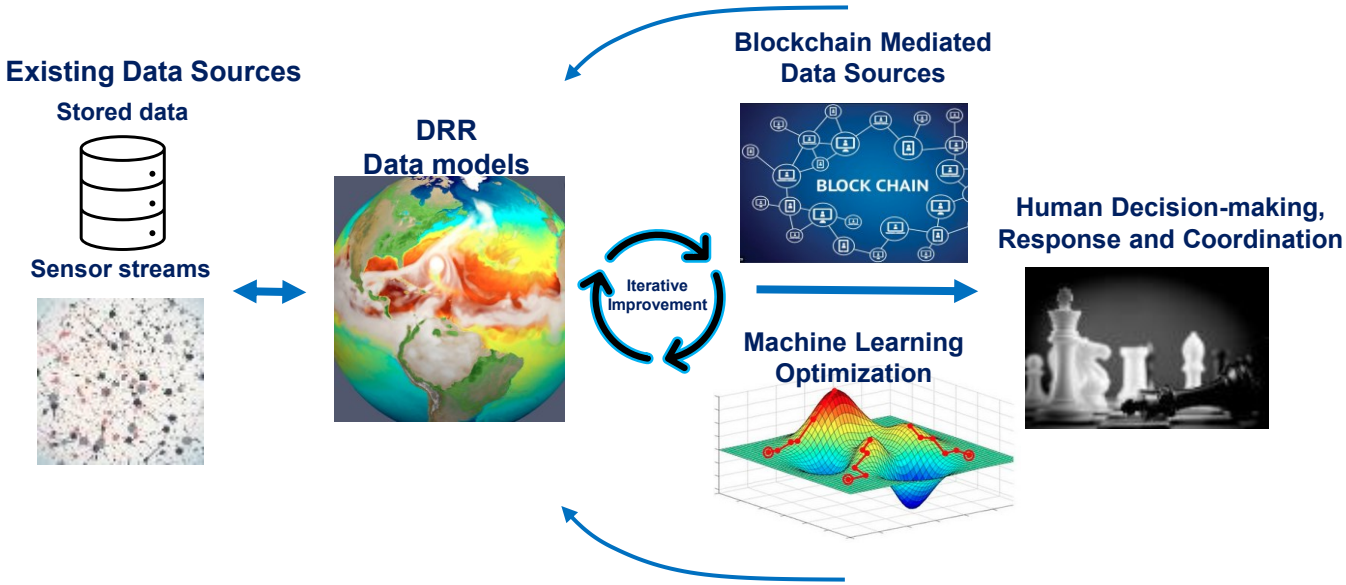
Floods in Pakistan

15 inches rain now versus normal 5 inches;
1/3 of Pakistan is underwater

Earthquake impact

Hurricanes 2008 – Fay, Gustav, Hannah

Blockchain-mediated data model enhancement



Blockchain features and value

Technical

No central administrator to assure trust

- There is no “god”
- There are many angels

Distributed ledger

- No one owns the transaction record
- Multiple sources of validation

Consensus algorithms

- Proof of Work, Proof of Stake
- Only one valid chain
- Resolution of competing chains

Smart contracts

- Complex conditions for transactions
- Not in original blockchain, Ethereum

Business

Identity /trust

- Trust
- Non-repudiation
- Anonymization / confidentiality

Provenance

Ownership – Virtual objects

- Payments
- Data
- Services
- Treatment regimens

Transferability

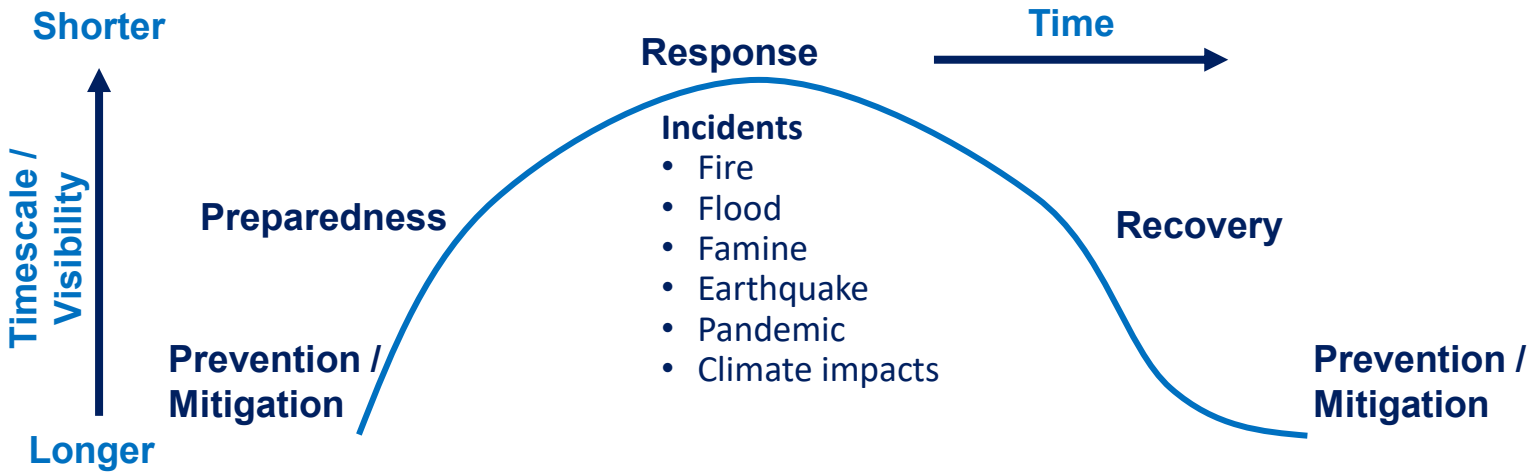
Anonymization / Confidentiality

Governance

- Pervasive rule-based contracts and verification (Smart Contracts)

Blockchain for DRR processes

Addressing *1) Risk, 2) Governance, 3) Resilience, 4) Preparedness*



Blockchain Applications

- Asset registration
- Personal / entity identity
- Data access, permissioning, validation
- Transaction records and conditions (supply chain)
- Contracts management

DRR Impact

- Funds and outcomes tracking
- Health data infrastructure – disease and vaccination tracking
- Predictive modeling – disaster risk mapping
- Carbon accounting and trading
- Infrastructure certification
- Resource allocation, distribution, and balancing
- Monitoring – GPS and IoT data integration and security

Blockchain-based data access process

Gov't data

Healthcare data

Physical infrastructure data

Sensor data

Complexity barriers

- Data sources
- Data ontologies
- Access protocols
- Network systems
- Security environments
- APIs
- Governance structures
- Uncertainty in data store validity
- Uncertainty in data representation of "reality"
- Need for synchronization with changes in what the data represents

Blockchain Broker for DRR Data

- **Global access**
- **Provenance** and **timestamping** of data generation and data access
- **Secure identity** for those generating and accessing data
- Trustful replication of metadata across servers
- **Consensus process** for data validation -
- Anonymization of data sources
- **Permission controls** for access to data and records of the granting of such permissions
- **Payment mechanisms** for access to certain classes of data
- Ability to create a "data supply chain" for generation and use of data
- Security for data generated by sensors
- **Integration of validated machine learning tools** for data analysis and elimination or control of noisy data sources
- Use and validation of **smart contracts** to manage data access and delivery

DRR Tools

- Machine learning
- Decision support systems
- Emergency notification
- Predictive models (early warning systems)
- Planning for investment in resilient infrastructure and other preparatory needs for enabling disaster response

Analytic Products

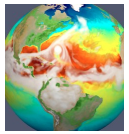
- Risk assessments
- Heat maps for disaster vulnerabilities
- Investment plans optimized for risk
- Monitoring systems for response

Data and metadata stewardship and validation

Customers

- Data modelers
- Service agencies
- Government agencies
- Enterprises subject to risk
- Risk managers, e.g., insurers

DRR Models



Local Integrated Data Systems

Data Steward

Data Services

Data needs/requests

Validated data flows

BDAE Governance and Oversight

Blockchain Smart Contract validation

- Repository of data access rules within Smart Contracts
- Data access / transaction records
- Status of metadata synchronization
- Attributes of data sources, e.g., metrics of data quality
- Validation process status for data / metadata

Data Product

Data Steward

Intra-domain Metadata

- Ontologies - definitions
- Exchange standards
- Search support
- Data rights
- Data relationships
- Status
- Locations
- Security
- Admin stewardship
- Access rules

DRR Data Domain

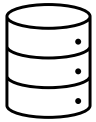
Data Steward

Inter-domain Metadata

DRR Data Domain

Experimental design

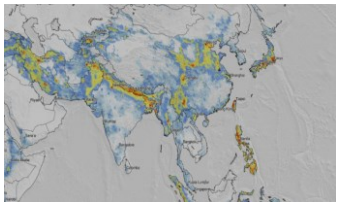
Select target set of data



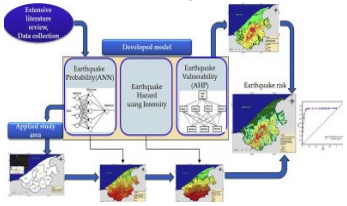
Implement Blockchain Smart Contracts to Validate/authorized data

Track
Use of Data in Models

Global Earthquake Hazard and Risk Models



Local Earthquake Vulnerability Models



Emergency Response Capability Models

Assess Value of Data to Model Customers

- Public health authorities
- Emergency response agencies
- Insurance companies
- Authorities regulating infrastructure
- Public and private service organizations

DRR challenges

- Cognitive obstacles to future orientation, consequences of exponential change, tipping point processes
- No magic bullet –
  - Multiple cumulative risks – Energy use, food production, permafrost thawing, ocean storage limits, embedded infrastructure
  - Multiple solutions – green energy, carbon transparency
- Lack of incentives for local change in behavior and investment
- Means for global coordination – first mover issues
- Compressed timeline for action – critical importance of the next two decades
- Disparate frames of reference for policy makers and technologists

“Remember son, there’s no future in big antlers.” — wise mother elk.
Just because a system has evolved, doesn’t mean it’s good.

Questions

- What are the most promising pilot types for Blockchain and DRR? Criteria for selecting candidates?
  (e.g., time-frame, impact, resource requirements, risks)
- What are the targets for funding sources?
- What are appropriate metrics?
- What governance mechanisms should oversee Blockchain applications for DRR?
- How can we promote the growth of communities of interest like this one and relationships with other groups?
- What publication topics would best serve our objectives?