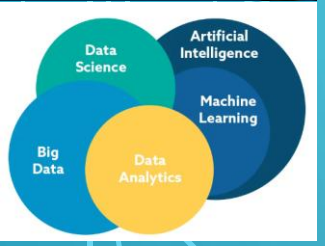
BIG DATA ANALYTICS FOR THE SUSTAINABLE DEVELOPMENT GOALS (SDGS) USING ARTIFICIAL INTELLIGENCE



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AGENDA

1. Abstract
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3. Overview of the Sustainable Development Goals (SDGs)
4. Big Data for SDG Monitoring
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    2. Types of Analytics
5. Statistical and Machine Learning Methods
    1. Regression & Predictive Modeling
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6. Geospatial and Remote Sensing Analytics
7. Causal Inference in SDG Policy Evaluation
8. Case Studies for SDG Implementation
    1. Poverty Mapping
    2. Climate Action
    3. Health Analytics
    4. Education Impact
9. Challenges and Ethical Considerations
10. Recommendations and Future Directions
11. Conclusion
12. References

ABSTRACT

- Big data analytics is transforming the monitoring and evaluation of the Sustainable Development Goals (SDGs). This paper explores methods, sources, and applications of big data to accelerate progress toward SDGs while addressing challenges related to ethics, privacy, and data quality. Application of Jordan SDGs indicators.

INTRODUCTION TO BIG DATA

- - Definition of Big Data
- - The 5 Vs: Volume, Velocity, Variety, Veracity, Value
- - Importance of Big Data in research
- - Role of AI in Big Data Analytics

INTRODUCTION OF SUSTAINABLE DEVELOPMENT GOALS (SDGS)

- The United Nations Sustainable Development Goals (SDGs) consist of 17 global goals aimed at ending poverty, protecting the planet, and ensuring prosperity for all. Traditional data sources often lag behind real-world events. Big data offers real-time insights that enhance decision-making and policy evaluation.

OVERVIEW OF SDGS

- SDG 1: No Poverty
- SDG 2: Zero Hunger
- SDG 3: Good Health and Well-being
- … (all 17 goals with description)


SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Overall Performance

Country Score

Regional Average = 65.6

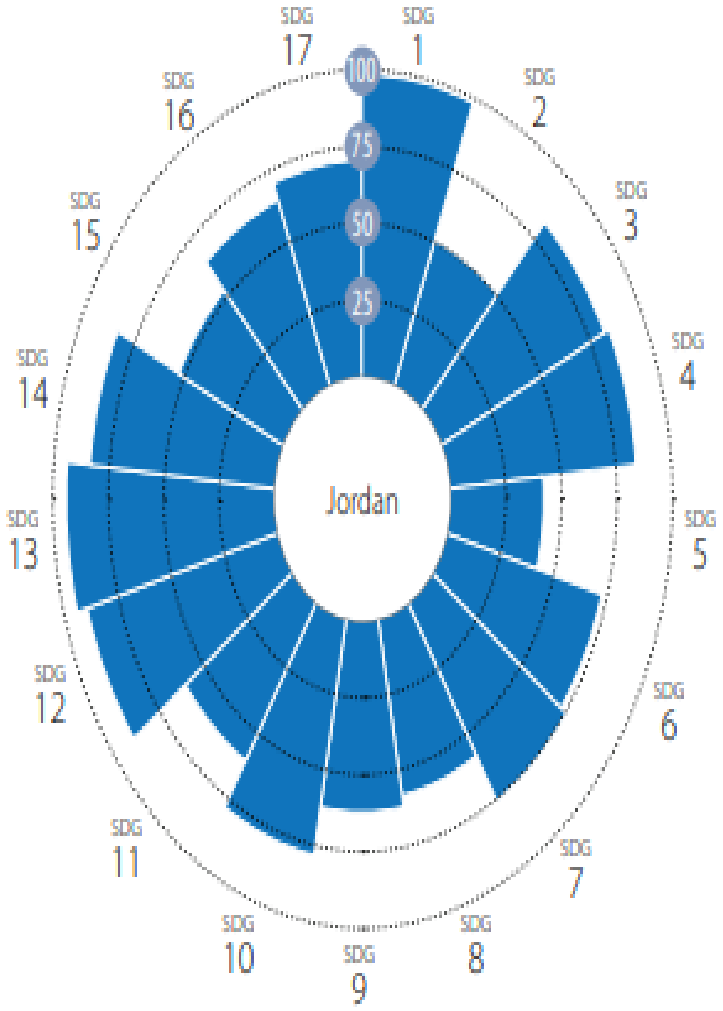
Country Rank

71 /167

Change in score since 2015 (p.p.)* **+ 6.7**

Missing data **3%**

Average Performance by SDG

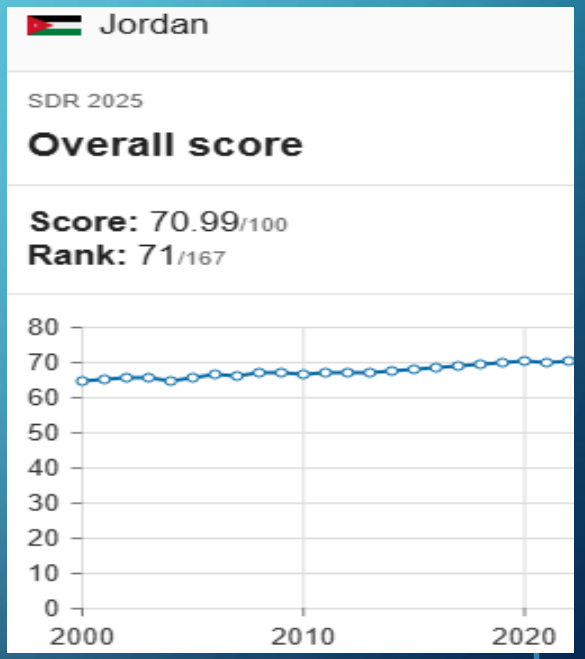


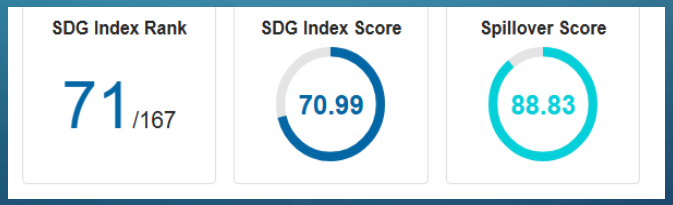
SDGs Rank

Countries are ranked by their overall score. The overall score measures the total progress towards achieving all 17 SDGs. The score can be interpreted as a percentage of SDG achievement. A score of 100 indicates that all SDGs have been achieved.

Rank	Country	Score	Performance by SDG
1	Finland	87.02	
2	Sweden	85.74	
3	Denmark	85.26	

71	Jordan	70.99	

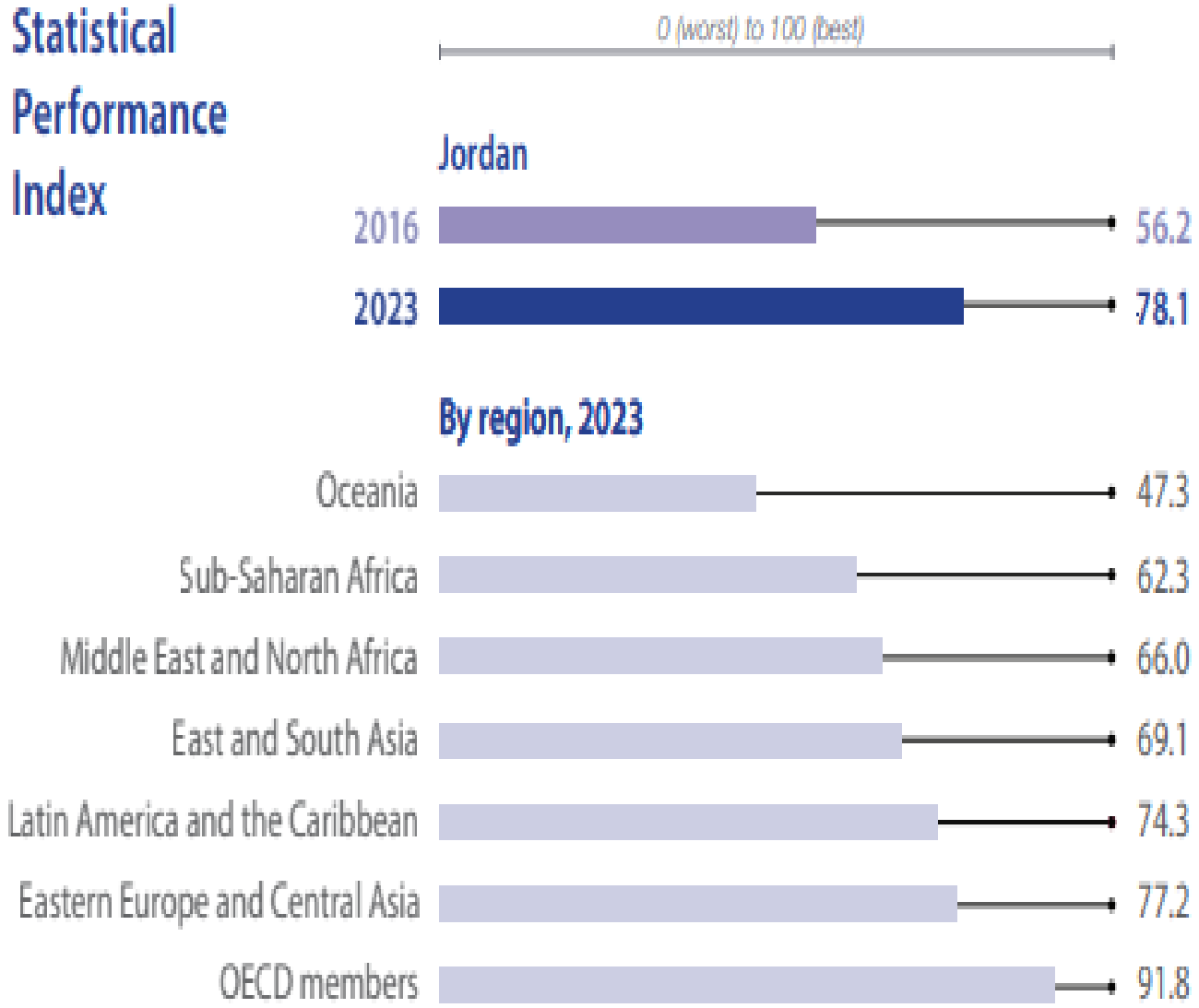




Sources: Sustainable Development Report 2025

Jordan –SDG index score

Statistical Performance Index



Number of Voluntary National Reviews (VNRs)

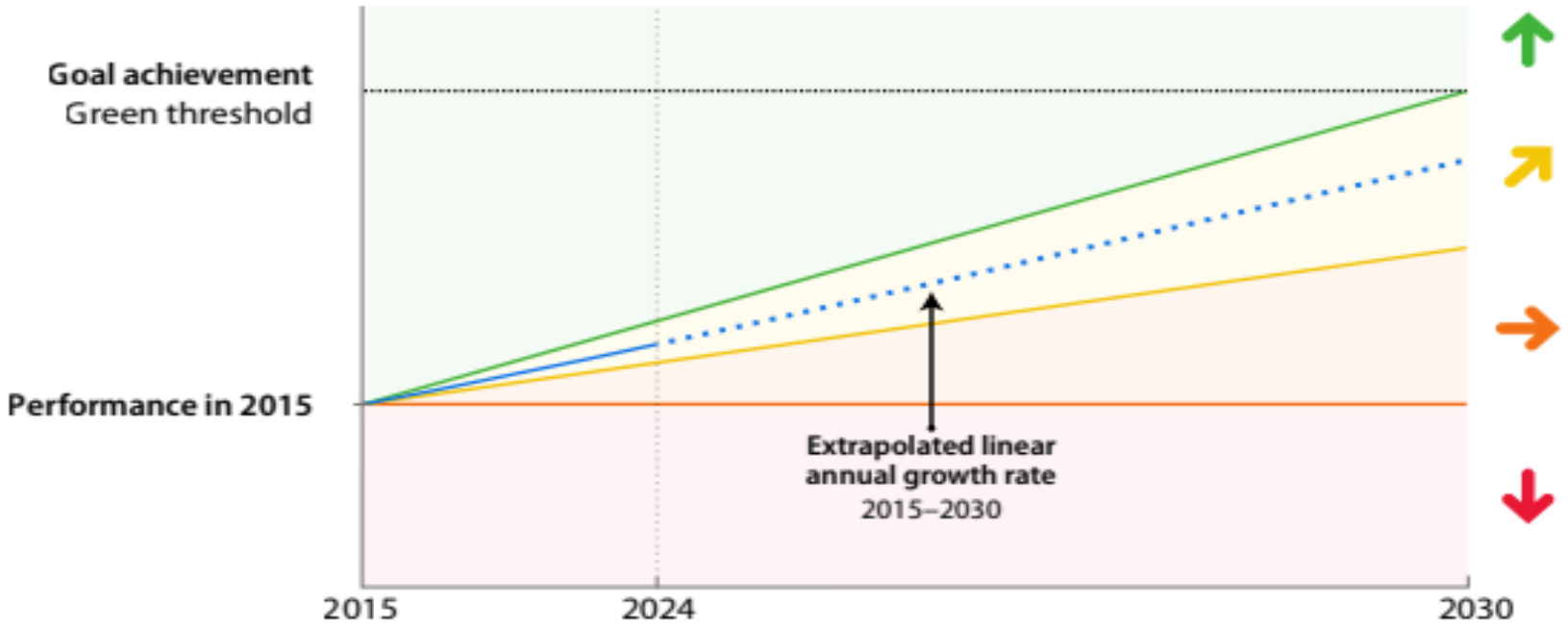
3

*Progress (in percentage points) is based on a set of 17 headline SDG indicators. Please see the methodology section for details.

The Four-arrow system for denoting SDG trends

Decreasing	Stagnating	Moderately improving	On track or Maintaining SDG achievement
Decreasing score, i.e. country moves in the wrong direction	Score remains stagnant or increases at a rate below 50% of the growth rate needed to achieve the SDG by 2030. Also denotes scores that currently exceed the target but have decreased since 2015	Score increases at a rate above 50% of the required growth rate but below the rate needed to achieve the SDG by 2030	Score increases at the rate needed to achieve the SDG by 2030 or performance has already exceeded SDG achievement threshold

Graphic representation of the methodology for SDG trends



Jordan – trend of SDG index score

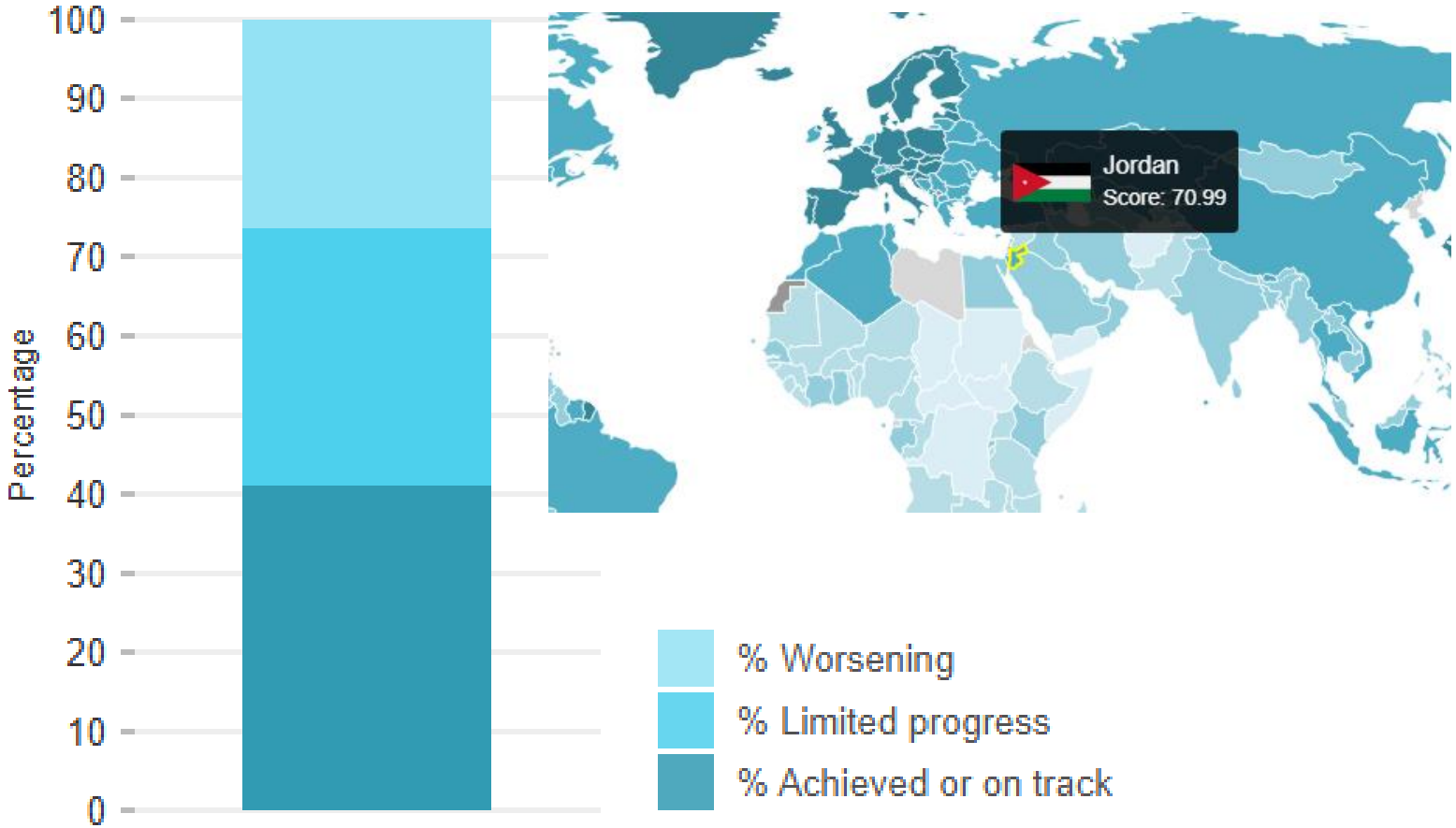
SDG1 – No Poverty	Value	Year	Rating	Trend
Poverty headcount ratio at $2.15/day (%)	0.8	2025	●	→
Poverty headcount ratio at $3.65/day (%)	1.2	2025	●	→
SDG2 – Zero Hunger				
Prevalence of undernourishment (%)	17.9	2022	●	↓
Prevalence of stunting in children under 5 years of age (%)	8.3	2023	●	●
Prevalence of wasting in children under 5 years of age (%)	2.3	2023	●	●
Minimum dietary diversity among children aged 6–23 months (%)	38.1	2019	●	●
Prevalence of obesity, BMI ≥ 30 (% of adult population)	38.5	2022	●	↓
Human Trophic Level (best 2–3 worst)	2.2	2022	●	→
Cereal yield (tonnes per hectare of harvested land)	1.2	2022	●	→
Sustainable Nitrogen Management Index (best 0–1.41 worst)	1.0	2018	●	→
Exports of hazardous pesticides (tonnes per million population)	0.7	2021	●	●
SDG3 – Good Health and Well-Being				
Maternal mortality ratio (per 100,000 live births)	30.8	2023	●	↑
Neonatal mortality rate (per 1,000 live births)	7.6	2023	●	↑
Mortality rate, under-5 (per 1,000 live births)	13.2	2023	●	↑
Incidence of tuberculosis (per 100,000 population)	3.4	2023	●	↑
New HIV infections (per 1,000 uninfected population, all ages)	0.0	2023	●	↑
Age-standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30 to 70 years (%)	11.6	2021	●	↑
Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	39.0	2019	●	●
Traffic deaths (per 100,000 population)	13.6	2021	●	↑
Life expectancy at birth (years)	77.8	2023	●	↑
Adolescent fertility rate (births per 1,000 females aged 15 to 19)	17.0	2021	●	↑
Births attended by skilled health personnel (%)	99.9	2023	●	●
Surviving infants who received 2 WHO-recommended vaccines (%)	95.0	2023	●	↑
Universal health coverage (UHC) index of service coverage (worst 0–100 best)	64.9	2021	●	↓
Subjective well-being (average ladder score, worst 0–10 best)	4.3	2024	●	↓

SDG4 — Quality Education				
Participation rate in pre-primary organized learning (% of children aged 4 to 6)	67.3	2023	●	●
Net primary enrollment rate (%)	97.3	2023	●	↑
Lower secondary completion rate (%)	93.4	2023	●	↑
Literacy rate (% of population aged 15 to 24)	99.0	2023	●	●
SDG5 — Gender Equality				
Demand for family planning satisfied by modern methods (% of females aged 15 to 49)	57.0	2024	●	→
Ratio of female-to-male mean years of education received (%)	92.9	2022	●	→
Ratio of female-to-male labor force participation rate (%)	22.8	2024	●	↓
Seats held by women in national parliament (%)	19.6	2025	●	→
SDG6 — Clean Water and Sanitation				
Population using at least basic drinking water services (%)	99.0	2022	●	↑
Population using at least basic sanitation services (%)	97.1	2022	●	→
Freshwater withdrawal (% of available freshwater resources)	105.2	2022	●	→
Anthropogenic wastewater that receives treatment (%)	91.2	2017	●	●
Scarce water consumption embodied in imports (m^3 H_2O eq/capita)	2,104.4	2024	●	↗
SDG7 — Affordable and Clean Energy				
Population with access to electricity (%)	100.0	2022	●	↑
Population with access to clean fuels and technology for cooking (%)	99.8	2022	●	→
CO_2 emissions from fuel combustion per total electricity output ($MtCO_2$/TWh)	0.9	2023	●	↑
Renewable energy share in total final energy consumption (%)	10.6	2021	●	↗
SDG8 — Decent Work and Economic Growth				
Adjusted GDP growth index (worst 0—100 best)	45.2	2023	●	●
Victims of modern slavery (per 1,000 population)	10.0	2022	●	●
Adults with an account at a bank or other financial institution or with a mobile-money-service provider (% of population aged 15 or over)	47.1	2021	●	↗
Unemployment rate (% of total labor force, ages 15+)	17.9	2025	●	↓
Fundamental labor rights are effectively guaranteed (worst 0—1 best)	0.54	2023	●	↗
Fatal work-related accidents embodied in imports (per million population)	0.6	2018	●	↑
Victims of modern slavery embodied in imports (per 100,000 population)	27.8	2018	●	●

SDG9 – Industry, Innovation and Infrastructure	Value	Year	Rating	Trend
Rural population with access to all-season roads (%)	96.1	2025	●	↑
Population using the internet (%)	92.5	2023	●	↑
Mobile broadband subscriptions (per 100 population)	67.5	2023	●	→
Logistics Performance Index: Infrastructure Score (worst 1–5 best)	2.7	2018	●	●
The Times Higher Education Universities Ranking: Average score of top 3 universities (worst 0–100 best)	42.0	2025	●	↑
Articles published in academic journals (per 1,000 population)	1.0	2023	●	↑
Expenditure on research and development (% of GDP)	0.7	2016	●	●
Total patent applications by applicant's origin (per million population)	5.0	2023	●	↓
SDG10 – Reduced Inequalities				
Gini coefficient	33.7	2010	●	●
Palma ratio	1.4	2010	●	●
SDG11 – Sustainable Cities and Communities				
Proportion of urban population living in slums (%)	16.7	2022	●	↗
Annual mean concentration of PM2.5 (µg/m³)	30.0	2023	●	→
Access to improved water source, piped (% of urban population)	86.7	2022	●	↓
Population with convenient access to public transport in cities (%)	9.3	2020	●	●
SDG12 – Responsible Consumption and Production				
Municipal solid waste (kg/capita/day)	0.8	2020	●	●
Electronic waste that is not recollected (kg/capita)	6.0	2022	●	●
Production-based air pollution (DALYs per 1,000 population)	1.9	2024	●	↑
Air pollution associated with imports (DALYs per 1,000 population)	2.8	2024	●	↗
Production-based nitrogen emissions (kg/capita)	9.2	2024	●	↑
Nitrogen emissions associated with imports (kg/capita)	12.9	2024	●	↗
Exports of plastic waste (kg/capita)	0.1	2023	●	↑
SDG13 – Climate Action				
CO_2 emissions from fossil fuel combustion and cement production (tCO_2/capita)	1.9	2023	●	↑
GHG emissions embodied in imports (tCO_2/capita)	2.0	2024	●	→
CO_2 emissions embodied in fossil fuel exports (tonnes/capita)	0.0	2023	●	●

SDG14 — Life Below Water					
Mean area that is protected in marine sites important to biodiversity (%)					
Ocean Health Index: Clean Waters score (worst 0–100 best)		57.2	2024		
Fish caught from overexploited or collapsed stocks (% of total catch)					
Fish caught by trawling or dredging (%)		0.0	2019		
Fish caught that are then discarded (%)		0.0	2019		
Marine biodiversity threats embodied in imports (per million population)		0.2	2018		
SDG15 — Life on Land					
Mean area that is protected in terrestrial sites important to biodiversity (%)		12.7	2023		
Mean area that is protected in freshwater sites important to biodiversity (%)		18.7	2023		
Red List Index of species survival (worst 0–1 best)		0.96	2023		
Permanent deforestation (% of forest area, 3-year average)					
Imported deforestation (m^2/capita)		7.5	2022		
SDG16 — Peace, Justice and Strong Institutions					
Homicides (per 100,000 population)		1.0	2023		
Crime is effectively controlled (worst 0–1 best)		0.85	2023		
Unsentenced detainees (% of prison population)		39.0	2015		
Birth registrations with civil authority (% of children under age 5)		98.0	2018		
Corruption Perceptions Index (worst 0–100 best)		49.0	2024		
Children involved in child labor (%)		1.7	2016		
Exports of major conventional weapons (TIV constant million USD per 100,000 population)		0.8	2024		
Press Freedom Index (worst 0–100 best)		35.3	2025		
Access to and affordability of justice (worst 0–1 best)		0.55	2023		
Timeliness of administrative proceedings (worst 0–1 best)		0.55	2023		
Expropriations are lawful and adequately compensated (worst 0–1 best)		0.55	2023		
SDG17 — Partnerships for the Goals					
Government spending on health and education (% of GDP)		5.7	2022		
For high-income and all OECD DAC countries: International concessional public finance, including official development assistance (% of GNI)					
Other countries: Government revenue excluding grants (% of GDP)		23.5	2022		
Corporate Tax Haven Score (best 0–100 worst)	*	0	2024		
Shifted profits of multinationals (US$ billion)	*	0.0	2021		
Statistical Performance Index (worst 0–100 best)		78.1	2023		
Index of countries' support to UN-based multilateralism (worst 0–100 best)		70.5	2025		

Status of SDG targets for Jordan (% trend indicators)




Human-machine collaboration
Machine-machine collaboration
Sustainable
AR & VR
Data analytics
AI/ML models
Additive & substractive manufacturing
Autonomous delivery
Privacy, & security
Cloud infrastructure
Smart sensors
AI
Wearables
Smart contracts/ blockchain
5G networks
Smart factories
5G

- 1.1 International poverty
- 1.2 National poverty
- 1.3 Social protection
- 1.4 Access to basic services
- 1.5 Resilience to disasters
- 1.a Government spending on essential services
- 1.b Poverty eradication policies

- 2.1 Undernourishment and food security
- 2.2 Malnutrition
- 2.3 Small-scale food producers
- 2.4 Productive and sustainable agriculture
- 2.5 Genetic resources for agriculture
- 2.a Investment in agriculture
- 2.b Agricultural export subsidies
- 2.c Food price anomalies

- 3.1 Maternal mortality
- 3.2 Child mortality
- 3.3 Communicable diseases
- 3.4 NCD and mental health
- 3.5 Substance abuse and treatment
- 3.6 Road traffic accidents
- 3.7 Sexual and reproductive health
- 3.8 Universal health coverage
- 3.9 Health impact of pollution
- 3.a Tobacco control
- 3.b Immunization coverage
- 3.c Health workforce
- 3.d Management of health risks

- 4.1 Effective learning outcomes
- 4.2 Early childhood education
- 4.3 TVET and tertiary education
- 4.4 Skills for employment
- 4.5 Equal access to education
- 4.6 Adult literacy and numeracy
- 4.7 Sustainable development education
- 4.a Education facilities
- 4.b ODA for scholarships
- 4.c Qualified teachers

- 5.1 Legal frameworks on gender equality
- 5.2 Violence against women and girls
- 5.3 Child marriage
- 5.4 Unpaid care and domestic work
- 5.5 Women in leadership
- 5.6 Reproductive health access and rights
- 5.a Equal economic rights for women
- 5.b Technology for women empowerment
- 5.c Gender-responsive budgeting

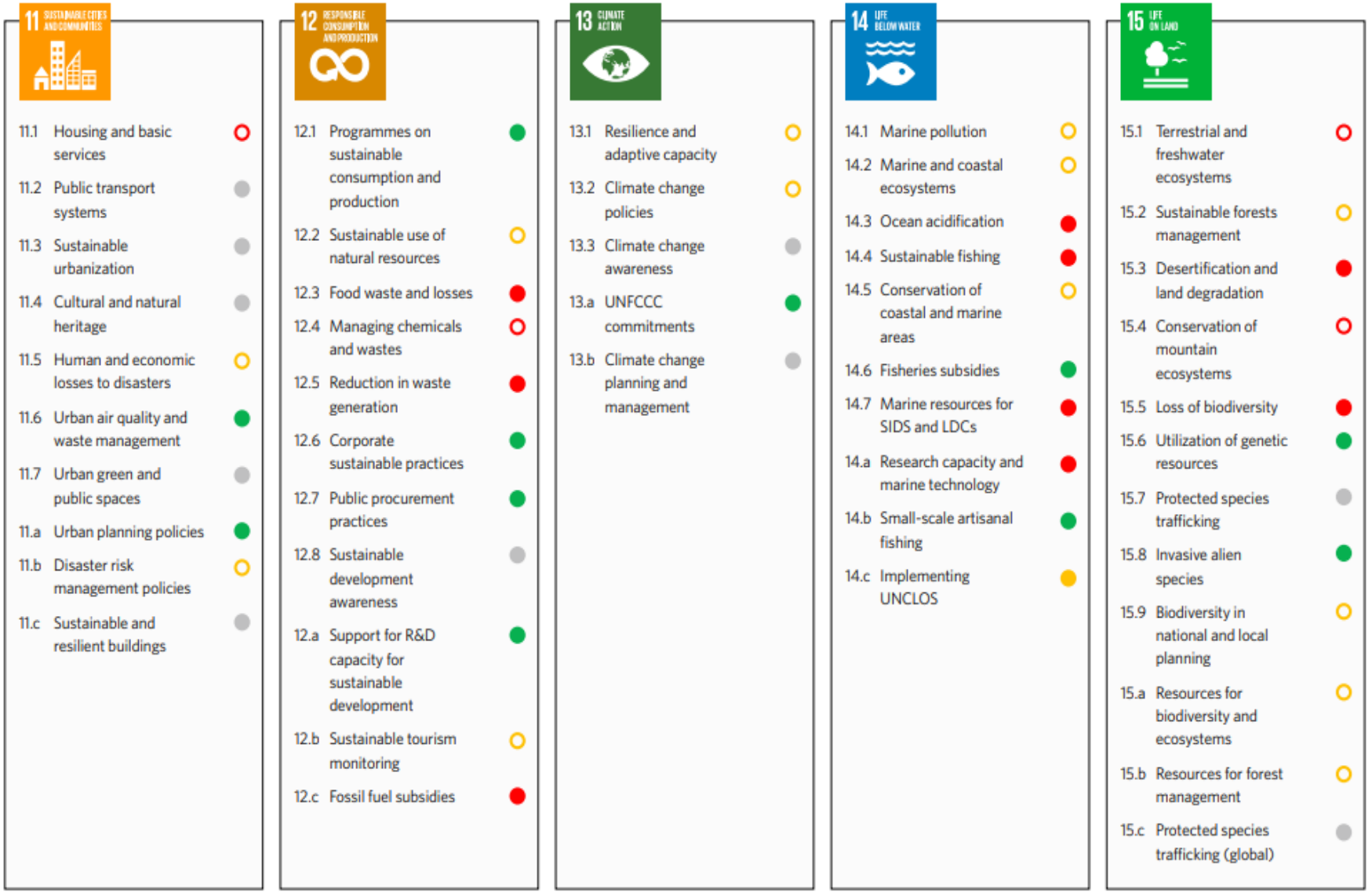
- 6.1 Safe drinking water
- 6.2 Access to sanitation and hygiene
- 6.3 Water quality
- 6.4 Water-use efficiency
- 6.5 Transboundary water cooperation
- 6.6 Water-related ecosystems
- 6.a International cooperation on water and sanitation
- 6.b Participatory water and sanitation management

- 7.1 Access to energy services
- 7.2 Share of renewable energy
- 7.3 Energy efficiency
- 7.a International cooperation on energy
- 7.b Investing in energy infrastructure

- 8.1 Economic growth
- 8.2 Economic productivity
- 8.3 Formalization of SMEs
- 8.4 Material resource efficiency
- 8.5 Full employment and decent work
- 8.6 Youth NEET
- 8.7 Child and forced labour
- 8.8 Labour rights and safe working environment
- 8.9 Sustainable tourism
- 8.10 Access to financial services
- 8.a Aid for Trade
- 8.b Strategy for youth employment

- 9.1 Infrastructure development
- 9.2 Sustainable/inclusive industrialization
- 9.3 Small-scale industries' access to finance
- 9.4 Sustainable and clean industries
- 9.5 Research and development
- 9.a ODA for infrastructure
- 9.b Domestic technology development
- 9.c Access to ICT and the Internet

- 10.1 Income growth of bottom 40 per cent
- 10.2 Income distribution
- 10.3 Eliminate discrimination
- 10.4 Fiscal and social protection policies
- 10.5 Regulation of financial markets
- 10.6 Inclusive global governance
- 10.7 Safe migration and mobility
- 10.a Special and differential treatment (WTO)
- 10.b Resource flows for development
- 10.c Remittance costs


11 SUSTAINABLE CITIES AND COMMUNITIES
11.1 Housing and basic services
11.2 Public transport systems
11.3 Sustainable urbanization
11.4 Cultural and natural heritage
11.5 Human and economic losses to disasters
11.6 Urban air quality and waste management
11.7 Urban green and public spaces
11.a Urban planning policies
11.b Disaster risk management policies
11.c Sustainable and resilient buildings
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
12.1 Programmes on sustainable consumption and production
12.2 Sustainable use of natural resources
12.3 Food waste and losses
12.4 Managing chemicals and wastes
12.5 Reduction in waste generation
12.6 Corporate sustainable practices
12.7 Public procurement practices
12.8 Sustainable development awareness
12.a Support for R&D capacity for sustainable development
12.b Sustainable tourism monitoring
12.c Fossil fuel subsidies
13 CLIMATE ACTION
13.1 Resilience and adaptive capacity
13.2 Climate change policies
13.3 Climate change awareness
13.a UNFCCC commitments
13.b Climate change planning and management
14 LIFE BELOW WATER
14.1 Marine pollution
14.2 Marine and coastal ecosystems
14.3 Ocean acidification
14.4 Sustainable fishing
14.5 Conservation of coastal and marine areas
14.6 Fisheries subsidies
14.7 Marine resources for SIDS and LDCs
14.a Research capacity and marine technology
14.b Small-scale artisanal fishing
14.c Implementing UNCLOS
15 LIFE ON LAND
15.1 Terrestrial and freshwater ecosystems
15.2 Sustainable forests management
15.3 Desertification and land degradation
15.4 Conservation of mountain ecosystems
15.5 Loss of biodiversity
15.6 Utilization of genetic resources
15.7 Protected species trafficking
15.8 Invasive alien species
15.9 Biodiversity in national and local planning
15.a Resources for biodiversity and ecosystems
15.b Resources for forest management
15.c Protected species trafficking (global)

- 16.1 Reduction of violence and related deaths
- 16.2 Human trafficking
- 16.3 Justice for all
- 16.4 Illicit financial and arms flows
- 16.5 Corruption and bribery
- 16.6 Effective institutions
- 16.7 Inclusive decision-making
- 16.8 Inclusive global governance
- 16.9 Legal identity
- 16.10 Public access to information
- 16.a National human rights institutions
- 16.b Non-discriminatory laws

- 17.1 Tax and other revenue collection
- 17.2 ODA commitment by developed countries
- 17.3 Additional financial resources for development
- 17.4 Debt sustainability
- 17.5 Investment promotion for LDCs
- 17.6 Access to technology
- 17.7 Transfer of technologies
- 17.8 Use of the Internet
- 17.9 Capacity-building for SDGs
- 17.10 Multilateral trading system (WTO)
- 17.11 Exports of developing countries
- 17.12 Duty-free market access for LDCs
- 17.13 Global macroeconomic stability
- 17.14 Policy coherence for sustainable development
- 17.15 Respect country's policy space
- 17.16 Global partnership for sustainable development
- 17.17 Partnerships (public, private, CSO)
- 17.18 National statistics availability
- 17.19 Statistical capacity

Legend

- On track or target met
- Moderate progress, but acceleration needed
- Marginal progress, and significant acceleration needed
- Stagnation
- Regression
- Insufficient data

List of acronyms and abbreviations

CSO: Civil society organization

ICT: Information and communications technology

NCD: Non-communicable disease

NEET: Not in employment, education or training

ODA: Official development assistance

R&D: Research and development

SME: Small and medium enterprise

TVET: Technical and vocational education and training

UNCLOS: United Nations Convention on the Law of the Sea

UNFCCC: United Nations Framework Convention on Climate Change

WTO: World Trade Organization

For further details, please see the SDG Progress Chart 2025. Technical note at: https://unstats.un.org/sdgs/report/2025/

BIG DATA SOURCES FOR SDGS

- **Satellite Imagery:** Land use, agriculture, urban expansion
- **IoT and Sensors:** Environmental monitoring, energy consumption
- **Mobile Phone Data:** Population mobility, migration
- **Social Media:** Public sentiment, awareness tracking
- **Survey & Administrative Data:** Household surveys, census

STATISTICAL CONCEPTS IN BIG DATA

- Descriptive vs. Inferential Statistics

- Sampling in large datasets

- Correlation and Regression

- Hypothesis Testing

- Dealing with data heterogeneity

DATA PREPROCESSING

- Data Cleaning: Missing values & outliers

- Feature Engineering

- Normalization and Scaling

- Dimensionality Reduction (PCA)

- Importance of reproducibility

AI AND MACHINE LEARNING FOR BIG DATA

- SUPERVISED VS. UNSUPERVISED LEARNING

- KEY ALGORITHMS: REGRESSION, DECISION TREES, CLUSTERING

- DEEP LEARNING OVERVIEW

- INTEGRATING AI WITH STATISTICAL MODELS

TOOLS AND FRAMEWORKS

- Python (NumPy, Pandas, Scikit-learn)

- PySpark for distributed data

- Cloud-based tools: Google Colab, AWS SageMaker

- Visualization: Tableau, Power BI, Plotly

CASE STUDIES IN RESEARCH

- Healthcare: Predictive diagnostics

- Finance: Fraud detection

- Social Science: Sentiment analysis

- Engineering: Predictive maintenance

ETHICS, BIAS, AND DATA PRIVACY

- - Data Bias and Fairness
- - Data Governance
- - Ethical AI frameworks
- - Privacy in data collection and sharing

SUMMARY & TAKEAWAYS

- Big Data requires hybrid statistical–AI approaches

- Preprocessing and feature selection are critical

- AI enables scalable, adaptive analytics

- Ethics and reproducibility matter

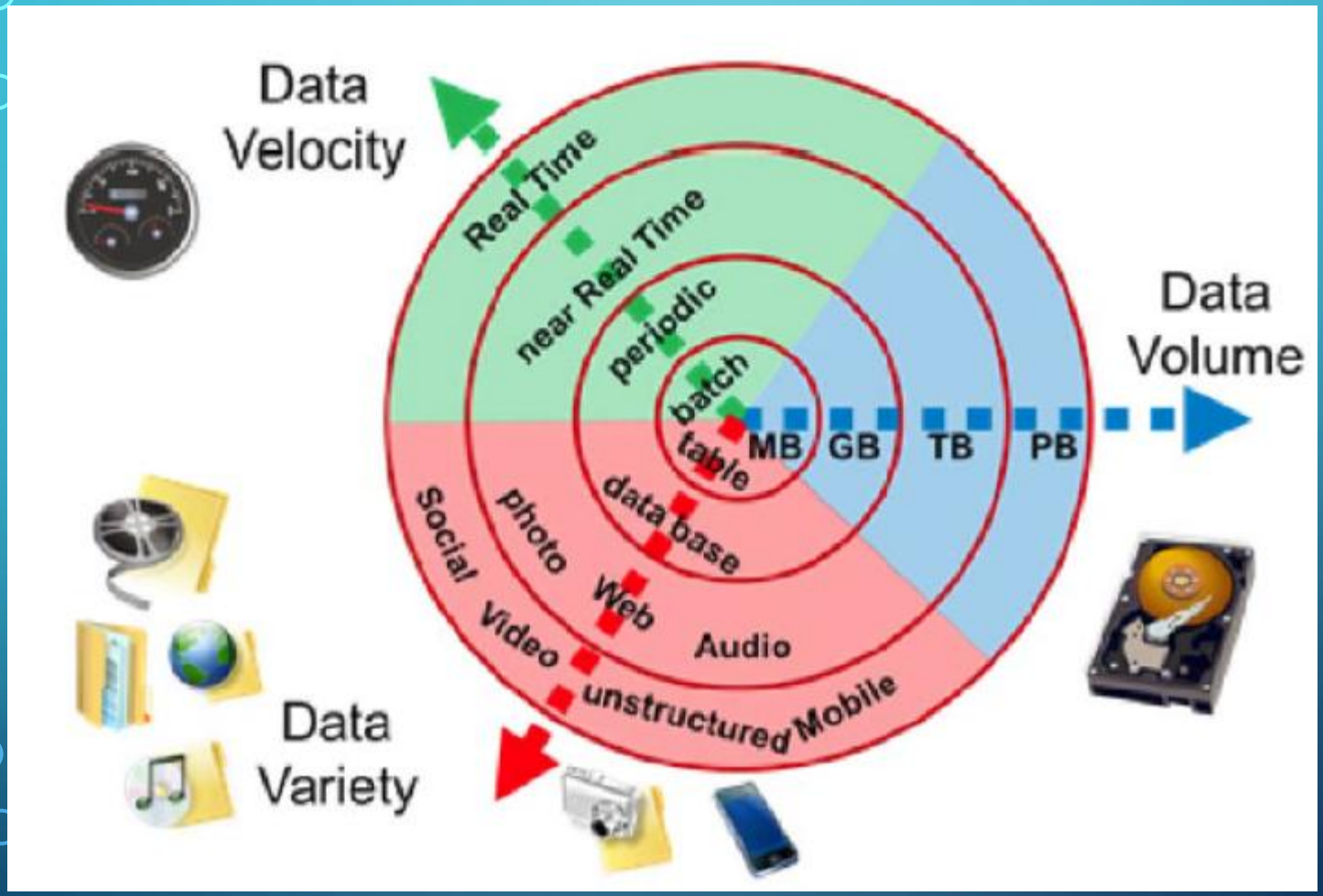

Top
Big Data
Tools
Spark

BIG DATA TOOLS

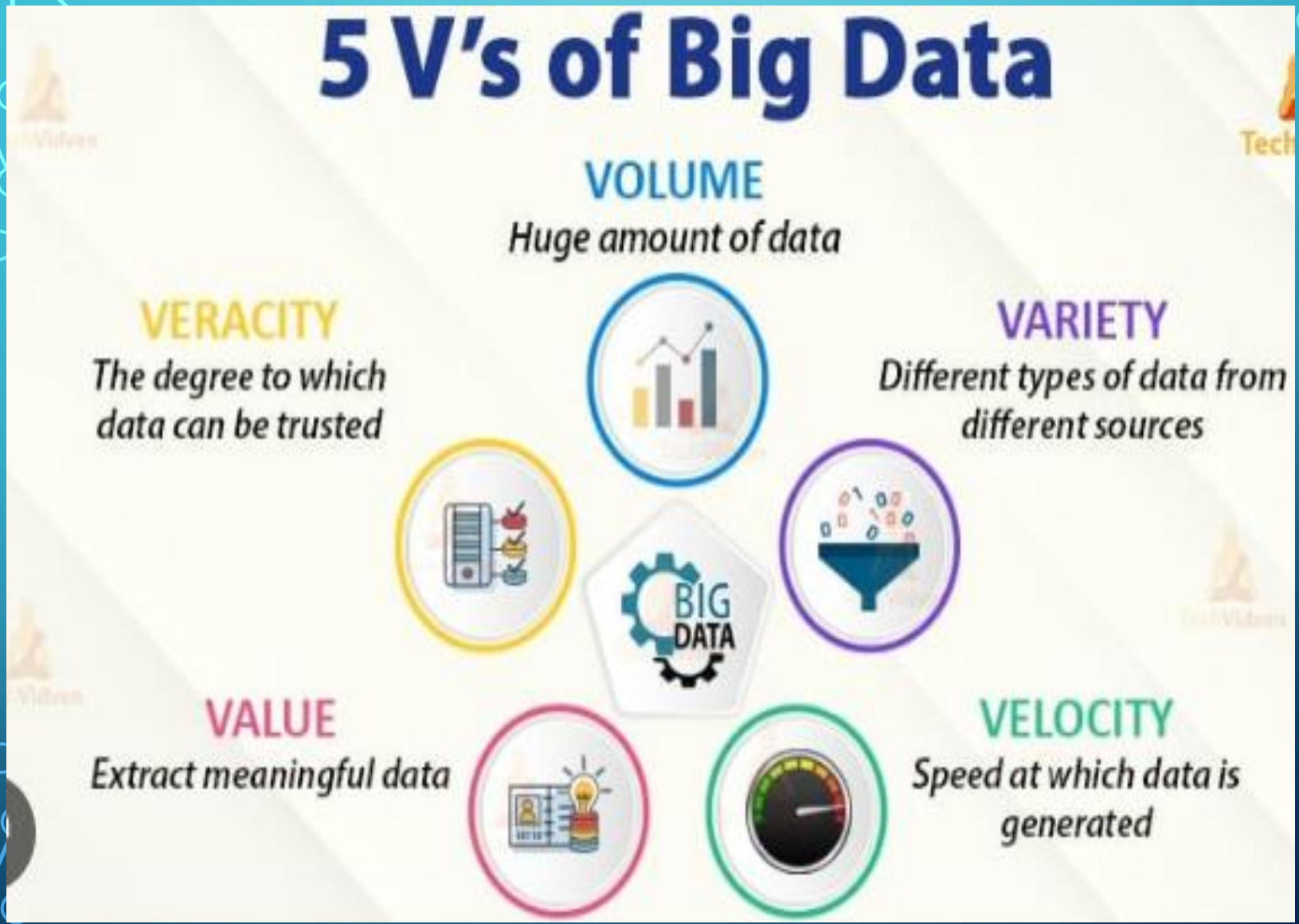
Apache Hadoop

The Apache® Hadoop® project develops open-source software for reliable, scalable, distributed computing.

The Apache Hadoop software library is a framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage. Rather than rely on hardware to deliver high-availability, the library itself is designed to detect and handle failures at the application layer, so delivering a highly-available service on top of a cluster of computers, each of which may be prone to failures.


Data Velocity
Real Time
near Real Time
periodic
batch
table
data base
photo
Web
Social
Video
Audio
unstructured
Mobile
MB
GB
TB
PB
Data Volume
Data Variety

5 V's of Big Data



PYTHON

- Python is a high-level, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation. Python is dynamically type-checked and garbage-collected.

STATISTICAL & MACHINE LEARNING METHODS

- **Statistical Models:** Regression, Bayesian models, time series, panel data
- **Machine Learning:** Random Forest, XGBoost, clustering, anomaly detection
- **Deep Learning:** CNNs for image analysis, LSTMs for temporal data

GEOSPATIAL ANALYTICS

- Land cover classification
- NDVI for vegetation monitoring
- Flood detection and mapping

CAUSAL INFERENCE FOR SDG POLICY

- Difference-in-Differences (DiD)
- Synthetic Control Methods
- Double Machine Learning and Causal Forests

CASE STUDIES

- Poverty Mapping: Satellite imagery + ML for small-area poverty estimation
- Air Quality Forecasting: IoT sensors + LSTM models
- Education Program Evaluation: Policy impact using DiD

CHALLENGES & ETHICS

- Data quality and missing values
- Bias in algorithms
- Privacy and security
- Governance and transparency

DIFFERENCE BETWEEN "OLD" STATISTICAL ANALYSIS OF BIG DATA FOR SDGS AND "NEW" APPROACHES USING AI

OLD STATISTICAL ANALYSIS OF BIG DATA FOR SDGS

- "Old" methods generally refer to **traditional statistics**, which were heavily used before the rise of AI/ML tools in big data. Key characteristics:

- **Techniques Used**

- Descriptive statistics: Mean, median, variance, correlations.
- Classical inferential statistics: t-tests, ANOVA, chi-square tests.
- Regression models: Linear regression, logistic regression, Poisson regression, etc.
- Time series and panel data analysis: ARIMA, fixed effects, random effects models

OLD STATISTICAL ANALYSIS OF BIG DATA FOR SDGS-**STRENGTHS**

- Good for hypothesis-driven analysis: You test a specific question (e.g., does rainfall affect crop yield in a region?).
- Statistically rigorous: Provides p-values, confidence intervals, effect sizes.
- Transparent and interpretable: Easy to explain to policymakers and stakeholders.

OLD STATISTICAL ANALYSIS OF BIG DATA FOR SDGS-**LIMITATIONS**

- Struggles with **high-dimensional or unstructured data:** satellite images, social media, IoT sensor streams.
- Assumes **linear relationships** or simple parametric distributions.
- Limited **predictive power** for complex patterns.
- Cannot easily handle real-time streaming data

OLD STATISTICAL ANALYSIS OF BIG DATA FOR SDGS-**EXAMPLE IN SDGS:**

- Using household surveys to measure poverty (SDG 1) with logistic regression to predict the likelihood of poverty based on income, education, and employment.

NEW STATISTICAL ANALYSIS USING AI FOR BIG DATA

- "New" methods combine **AI and machine learning** with statistical reasoning, especially to analyze big, messy, or complex data for SDGs.
- **Techniques Used**
- Machine Learning (ML): Random forests, gradient boosting (XGBoost, LightGBM).
- Deep Learning (DL): CNNs for satellite images (land use, crop health), RNNs/LSTMs for time series (e.g., climate data).
- Hybrid Models: Statistical methods + ML (e.g., Bayesian neural networks, causal forests).
- Reinforcement learning for adaptive policy simulations.

NEW STATISTICAL ANALYSIS USING AI FOR BIG DATA-**STRENGTHS**

- Can handle **large, unstructured, or heterogeneous data** (images, text, social media, sensor data).
- Can capture **nonlinear, complex relationships** that classical stats miss.
- High **predictive power**, often better for forecasting trends (e.g., disease outbreaks, migration).
- Real-time analytics possible with streaming data.
- Some AI methods incorporate **causal inference** to estimate impact of interventions

NEW STATISTICAL ANALYSIS USING AI FOR BIG DATA-**LIMITATIONS**

- Often less interpretable ("black box" models), though explainable AI (XAI) is improving this.
- Requires more computing power and data preprocessing.
- Risk of **overfitting**, bias, and ethical concerns if models are poorly validated.

NEW STATISTICAL ANALYSIS USING AI FOR BIG DATA-**EXAMPLE IN SDGS:**

- Using **satellite imagery + CNN** to detect deforestation for SDG 15 (Life on Land) in near-real time.
- Predicting urban poverty (SDG 1) by combining mobile phone usage patterns, geospatial data, and ML models.
- Using NLP to analyze social media for SDG 3 (health awareness campaigns) and detecting misinformation.

KEY DIFFERENCES (SUMMARY TABLE)

Feature	Old Statistical Analysis	New AI/ML Analysis
Data Type	Structured, small-to-medium datasets	Structured, unstructured, streaming, high-dimensional
Relationships	Linear, parametric	Non-linear, complex, hierarchical
Predictive Power	Limited	High
Real-Time Analytics	Rare	Possible
Interpretability	High	Often low (but explainable AI improving this)
Automation	Manual data cleaning & analysis	Automated feature extraction, model training
Use Case Examples	Poverty estimation via surveys, linear regression	Satellite imagery analysis, predictive modeling, social media analytics, climate modeling

OLD AND NEW

- **Old statistics**: Reliable, interpretable, hypothesis-driven, limited to structured data.

- **New AI-based analytics**: Scalable, predictive, capable of handling complex and unstructured data, ideal for real-time SDG monitoring, but requires careful validation and interpretation.

BIG DATA ANALYTICS FOR SDGS: OLD VS AI-BASED METHODS

Feature	Old Statistical Analysis	AI/ML Analysis
Data Type	Structured (surveys, censuses, administrative data)	Structured + unstructured + streaming (satellite images, IoT, social media)
Techniques	Linear regression, logistic regression, t-tests, ANOVA, time series, panel data	Machine learning (Random Forest, XGBoost), Deep Learning (CNNs, LSTMs), Hybrid models, Causal ML
Strengths	- High interpretability - Statistically rigorous - Easy to explain to policymakers	- High predictive power - Captures nonlinear and complex patterns - Handles large-scale and real-time data
Limitations	- Limited predictive power - Cannot handle unstructured/large data - Assumes linear relationships	- Less interpretable (black box) - Requires high computational resources - Risk of bias if not validated
Examples in SDGs	Poverty estimation from surveys (SDG 1), linear models for education impact (SDG 4)	Satellite imagery + CNN for deforestation (SDG 15), Social media analytics for health awareness (SDG 3), Predictive modeling for migration (SDG 10)
Visual Elements (for infographic)	Spreadsheets, bar/line charts, survey icons	Neural network diagrams, satellite imagery, social media icons, real-time streaming

Model / Method	Use Case in SDGs	Pros	Cons	Data Type
Linear Regression	Predict income, crop yield, education outcomes	Simple, interpretable, statistically rigorous	Limited to linear relationships, struggles with high-dimensional data	Structured, tabular
Logistic Regression	Predict poverty (yes/no), disease incidence	Interpretable, standard for binary outcomes	Cannot capture complex non-linear patterns	Structured, tabular
Poisson / Negative Binomial Regression	Count data: disease cases, population metrics	Handles count outcomes	Assumes specific distributions, sensitive to overdispersion	Structured, tabular
Time Series Models (ARIMA, SARIMA, Prophet)	Forecast climate patterns, energy demand	Good for temporal trends	Limited for multivariate or nonlinear interactions	Structured, temporal
Panel / Fixed & Random Effects Models	Policy evaluation across countries/regions	Controls for unobserved heterogeneity	Requires panel data, assumes linearity	Structured, panel data
Multilevel / Hierarchical Models	Nested data: students in schools, patients in hospitals	Accounts for hierarchical structure, interpretable	Computationally intensive with large datasets	Structured, hierarchical
Random Forest / Gradient Boosting (XGBoost, LightGBM)	Poverty prediction, health risk modeling	Handles non-linearities, interactions, missing data	Less interpretable, can overfit	Structured & semi-structured
Neural Networks (MLP, CNN, RNN/LSTM)	Image classification (deforestation), time-series prediction (climate, migration)	Captures complex patterns, high predictive power	Black-box, needs large datasets & computing	Structured, unstructured, spatial/temporal
Causal ML (Double ML, Causal Forests)	Policy impact evaluation	Combines prediction with causal inference, robust	Complex to implement, interpretability challenges	Structured & semi-structured
Bayesian Models	Probabilistic forecasts, small-sample predictions	Incorporates prior knowledge, uncertainty quantification	Computationally intensive	Structured, tabular
Spatial / Geographically Weighted Regression (GWR)	Mapping poverty, climate hotspots	Accounts for spatial dependence	Limited for large datasets, less standard	Spatially-referenced data
Spatial-Temporal Models	SDG trends over time and space (urbanization, deforestation)	Captures both space and time patterns	Complex modeling, needs expertise	Spatial & temporal
Hybrid / Ensemble Models	Crop yield, multi-indicator SDG prediction	Combines strengths of multiple models, high accuracy	Complexity, computational cost	Mixed (structured + unstructured)

TRENDS IN SDG BIG DATA ANALYTICS

- Integration of **causal inference with AI** (e.g., double ML) to ensure predictions support policy decisions.
- **Geospatial ML + remote sensing** for agriculture, climate, and urban SDG monitoring.
- **Multimodal data fusion**: Combining text, image, and numeric data to get holistic insights.
- **Explainable AI for policy**: Ensuring AI insights are actionable and transparent.

BEST TOOLS FOR ANALYZING SDG BIG DATA

- **1. Traditional Statistical (Old) Tools**
- These tools are well-established, often more interpretable, and commonly used in official statistics and development research
- **2. AI / Machine-Learning (New) Tools**
- These are used for high-dimensional, unstructured, or streaming SDG data — such as satellite imagery, text, and IoT

1. TRADITIONAL STATISTICAL (OLD) TOOLS

- These tools are well-established, often more interpretable, and commonly used in official statistics and development research

Tool	What It's Good For in SDG Analysis
R / RStudio	R is a powerful statistical programming language used for regression, time-series, Bayesian modeling, and small-area estimation. Many NSOs and researchers use R for SDG indicator modeling. The **UNECE** toolkit "Statistics for SDGs" mentions small-area estimation tools. (UNECE)
Stata / SPSS / SAS	Widely used in social sciences: regression, panel data, hierarchical models, survey data analysis. SAS Viya (modern SAS) supports AI + analytics. (Wikipedia)
Excel / Google Sheets	Useful for quick exploratory data analysis, dashboards, basic descriptive statistics, and communicating with non-technical stakeholders.
SaTScan	Specifically for spatial / spatio-temporal cluster analysis. You can detect disease or event clusters across regions/time. (Wikipedia)

2. AI / MACHINE-LEARNING (NEW) TOOLS

- These are used for high-dimensional, unstructured, or streaming SDG data — such as satellite imagery, text, and IoT

Tool / Platform	Use in SDG Big Data Analytics
Python (with libraries like Pandas, Scikit-learn, TensorFlow, PyTorch)	A very common choice for ML and deep learning. You can build predictive models, neural networks, and more. Ideal for combining structured + unstructured data.
Dask	For scalable data processing in Python. Useful when your SDG data is very large (terabytes), enabling parallelization. (Wikipedia)
SAS Viya	A high-performance analytics platform that supports both traditional analytics and AI / ML workloads. Good for enterprise-grade or official-statistics use. (Wikipedia)
QGIS / GIS Tools	For geospatial analysis. QGIS is open-source GIS software used for mapping SDG indicators, working with spatial data, and geospatial modeling. (Wikipedia)
GDAL / PROJ	Libraries to work with geospatial raster and vector data. Useful for pre-processing satellite imagery, geographic transformations, and preparing data for spatial analysis. (Wikipedia)
UN Data Commons for the SDGs	A platform launched by UN DESA to explore, visualize, and analyze SDG data via AI-powered search and analytics. (United Nations)
text2sdg (R package)	Specifically built to **map any text data** to SDGs. It classifies text (e.g., reports, social media, documents) to SDG goals, making it very useful for unstructured text analysis. (arXiv)
OSDG 2.0	A multilingual tool for classifying text data according to SDGs. Very useful to analyze policy documents, news, or project reports. (arXiv)
AIDA (AI for Development Analytics)	A UNDP tool that uses ML to analyze unstructured evaluation reports and extract insights relevant to development and SDGs. (Medium)

HOW TO CHOOSE THE RIGHT TOOL

- **Data Type**
  - If your data is **structured (surveys, spreadsheets)** → R, SAS, Excel.
  - If it's **geospatial** → QGIS, GDAL, GIS libraries.
  - If it's **text or unstructured** → text2sdg, OSDG 2.0, Python NLP.
- **Scale**
  - For *small to moderate datasets*: R, Python, Excel.
  - For *big data / high volume*: Dask, SAS Viya, distributed Python environments.
- **Purpose**
  - **Descriptive / reporting**: UN Data Commons, Excel, QGIS.
  - **Predictive modeling**: Scikit-learn, TensorFlow, PyTorch.
  - **Causal / policy evaluation**: Python/R with causal inference libraries + small-area estimation.
- **Capacity & Resources**
  - Consider whether your team has ML expertise.
  - Look at computational resources: do you have GPU, cloud infrastructure?
  - Data governance: if using sensitive data, ensure proper ethics / privacy tools.

SUMMARY TABLE OF EXAMPLES

Category	Tool	Real SDG Example
Old	R	Poverty estimation using household surveys
Old	Stata	Country-level maternal mortality analysis
Old	SPSS	School performance comparison
Old	SaTScan	Disease outbreak detection
Old	Excel	Municipal SDG dashboard
New	Python ML	Predicting poverty from mobile data
New	TensorFlow	Deforestation detection via satellite
New	QGIS	Mapping climate vulnerability
New	text2sdg	Classifying SDG-related texts
New	Dask	Analyzing huge environmental sensor datasets

OLD VS NEW TOOLS FOR SDG BIG DATA ANALYSIS

Category	Old Tools (Traditional Statistics)	New Tools (AI / Machine Learning / Big Data)
Main Purpose	Statistical analysis, hypothesis testing, official reporting	High-dimensional analytics, prediction, automation, unstructured data
Common Tools	R, Stata, SPSS, SAS, Excel, SaTScan	Python (Scikit-learn, Pandas), TensorFlow, PyTorch, QGIS, Google Earth Engine, Dask, text2sdg, OSDG
Data Types Supported	Mostly structured data (surveys, censuses, admin data)	Structured + unstructured (text, images, video), geospatial, IoT, streaming data
Typical SDG Applications	Poverty estimation (SDG 1), health surveys (SDG 3), education outcomes (SDG 4), labour statistics (SDG 8)	Satellite monitoring (SDG 13 & 15), poverty prediction using mobile data (SDG 1), social media SDG sentiment (SDG 5 & 16), AI forecasting (SDG 7)
Core Methods	Regression models, ANOVA, time-series, panel data, cluster analysis, small area estimation	Machine learning (RF, XGBoost), deep learning (CNN, LSTM), NLP, causal ML, spatial ML
Strengths	- High interpretability	

Country	How AI / Big Data is Used	SDGs Involved	Source / Notes
China	Uses satellite SDGSAT-1 data, AI Earth observation models, and Big Earth Data Reports via CBAS; AI models (e.g., LingXi) predict SDG progress	SDG 2, 6, 11, 13, 14, 15	CBAS Big Earth Data Report; UN SDG Big Data Reports
Ghana	AI using drone imagery to detect marine litter and coastal pollution	SDG 14 (Life Below Water)	PARIS21 report
Colombia	National statistical office uses AI-driven SDG data integrations; big data for poverty and migration	SDG 1, 10	UN Big Data Task Team
United Kingdom	Uses AI in national statistics programs; machine learning for health and environment monitoring	SDG 3, 13	PARIS21 and UN Big Data Task Team
Mongolia	Computer vision on satellite images to detect slum housing ("gers") for poverty mapping	SDG 1 (No Poverty)	Academic research (Arxiv, 2024)
Denmark	Uses AI in official statistics for climate predictions and administrative data analysis	SDG 13 (Climate Action)	UN Big Data Task Team
India	Uses ML for agriculture forecasting, crop yield prediction, and remote sensing	SDG 2 (Zero Hunger), SDG 13	UN Big Data Task Team
Rwanda	Big data mobile phone analytics used for population mobility and poverty mapping	SDG 1, SDG 11	UN Global Pulse
South Africa	Uses AI + big data for energy forecasting, health surveillance, and geospatial modeling	SDG 3, SDG 7	UN Big Data Task Team
Finland	AI-enabled climate simulation models and sustainability forecasting	SDG 13, SDG 7	Nordic AI & SDG research
Sweden	National AI strategy linked to SDG monitoring and environmental analytics	SDG 12, 13	Nordic AI policy paper
Brazil	Deep learning applied to Amazon deforestation detection using satellite data	SDG 15 (Life on Land)	Research + INPE satellite data
United States	AI for wildfire prediction, climate modeling, health trend detection	SDG 3, SDG 13, SDG 15	AI for SDGs Observatory
Japan	Uses AI for disaster risk mapping, water management, and climate resilience	SDG 6, SDG 11, SDG 13	UNDRR partnerships
United Arab Emirates	AI for smart cities, real-time energy & water monitoring dashboards	SDG 7, SDG 11	UAE AI Strategy

OLD VS NEW TOOLS FOR SDG BIG DATA ANALYSIS IN ARAB COUNTRIES

Country	Old Tools Used (Statistics)	New Tools Used (AI / Big Data)	SDGs Most Impacted
United Arab Emirates (UAE)	Excel, SPSS, R for official indicators	AI dashboards, IoT data, machine learning for smart cities	SDG 7, 9, 11, 13
Saudi Arabia	Stata, R for economic + social indicator tracking	AI for energy optimization, smart transport, satellite data for desertification	SDG 7, 11, 13, 15
Qatar	Excel, R for national statistics	AI in smart city Lusail, satellite data for environmental monitoring	SDG 9, 11, 12
Egypt	SPSS, Stata for population and health surveys	Limited AI adoption; some projects use remote sensing for agriculture and river management	SDG 2, 6, 11
Jordan	SPSS, Stata for unemployment, poverty studies	AI piloted with UN for refugee population mobility and poverty mapping	SDG 1, 5, 10
Morocco	Excel, Stata for household surveys	Remote sensing + AI for drought monitoring, crop yield prediction	SDG 2, 13
Tunisia	SPSS, R for health and education analysis	Early use of AI for climate vulnerability mapping	SDG 3, 13
Oman	Excel, SPSS for economic + environmental data	Limited; AI in early stages for water resources and energy forecasting	SDG 6, 7
Bahrain	Excel, R for national indicator tracking	Uses AI in health analytics and public service automation	SDG 3, 9
Kuwait	Stata, Excel for official SDG reporting	AI in smart grid energy optimization and traffic analysis	SDG 7, 11
Lebanon	SPSS, R for poverty and health studies	Limited due to economic crisis; some academic AI research on environment	SDG 1, 3, 13
Iraq	Excel, Stata for reconstruction and economic stats	Minimal AI use; satellite images used by UN for crisis and conflict monitoring	SDG 11, 16
Sudan	SPSS for humanitarian data	UN uses AI for famine early-warning and flood mapping	SDG 2, 13
Yemen	Excel for humanitarian indicators	UN + NGOs use satellite AI models to detect displacement and food insecurity	SDG 2, 16

WHICH ARAB COUNTRIES LEAD IN AI FOR SDGS?

- **UAE** – Smart cities, real-time dashboards, IoT energy grid
- **Saudi Arabia** – AI strategy, smart transport, big environmental projects
- **Qatar** – AI in infrastructure, environment, and sustainability programs

AI & BIG DATA MODELS USED IN SDGS ANALYSIS (FULL OVERVIEW)

Machine Learning Models (Supervised Learning

Model	SDG Applications
Linear/Logistic Regression	Poverty estimation (SDG 1), health risk prediction (SDG 3)
Random Forest	Land use classification, poverty prediction using mobile data (SDG 1, 11)
Gradient Boosting (XGBoost, LightGBM)	Agricultural yield forecasting (SDG 2), energy demand forecasting (SDG 7)
Support Vector Machines (SVM)	Water contamination prediction (SDG 6), disease outbreak prediction (SDG 3)
K-Nearest Neighbors (KNN)	Education outcome prediction (SDG 4)
Naïve Bayes	NGO classification, social media SDG sentiment (SDG 16)

DEEP LEARNING MODELS (NEURAL NETWORKS)

Model	SDG Applications
Convolutional Neural Networks (CNNs)	Deforestation detection (SDG 15), flood mapping (SDG 13), crop health analysis (SDG 2)
Recurrent Neural Networks (RNN / LSTM / GRU)	Climate trend forecasting (SDG 13), energy load forecasting (SDG 7)
Transformer Models (BERT, GPT, LLaMA)	SDG text classification, policy analysis, misinformation detection (SDG 16)
Autoencoders	Anomaly detection (pollution spikes, SDG 14/15), fraud detection
Graph Neural Networks (GNNs)	Predicting infrastructure vulnerability (SDG 9, 11)

GEOSPATIAL AI (GEOAI) MODELS

Model	SDG Applications
UNet, SegNet (Image segmentation)	Flood detection, slum mapping, agricultural field segmentation
YOLO, Faster R-CNN (Object detection)	Detecting trees, buildings, marine debris, wildlife
Change Detection Networks (CDNet)	Monitoring deforestation, urban expansion
Spatial ML Models (Random Forest + GIS)	Mapping drought severity, soil health

BIG DATA ANALYTICS MODELS

Model	SDG Applications
Time-Series Forecasting (ARIMA, Prophet, LSTM)	Energy demand (SDG 7), food prices (SDG 2), CO_2 emissions (SDG 13)
Clustering (K-Means, DBSCAN)	Identifying poverty clusters, disease hotspots
Association Rule Mining (Apriori)	OD relationships in transport (SDG 11)
Bayesian Models	UN official SDG indicator uncertainty estimation

HYBRID / MULTIMODAL AI MODELS

Model	SDG Applications
Multimodal Transformers	Combining satellite images + climate text data for SDG 13
AI Digital Twins	Smart cities (SDG 11), energy grids (SDG 7)
Agent-Based Models + AI	Migration modeling, urban planning scenarios
Reinforcement Learning	Smart transportation optimization, renewable energy allocation

EXAMPLES OF SDG-SPECIFIC AI MODELS

SDG 1 – No Poverty

- Random Forest on mobile phone metadata (poverty mapping)
- CNN on satellite images to detect informal settlements

SDG 2 – Zero Hunger

- LSTM for crop yield forecasting
- GeoAI for vegetation health monitoring (NDVI)

SDG 3 – Health & Well-Being

- Disease outbreak prediction using SVM, Random Forest
- Deep learning for medical imaging

SDG 13 – Climate Action

- LSTM + Prophet for climate forecasting
- UNet for flood prediction
- Transformers for climate policy analysis

(and so on for all SDGs if needed)

SDG	Goal Title	Best AI Models	Why These Models Work Best
SDG 1	No Poverty	Random Forest, XGBoost, CNN (satellite), Clustering (K-means)	Poverty prediction from mobile data, slum detection from satellite images, identifying poverty clusters
SDG 2	Zero Hunger	LSTM, Prophet, UNet, Random Forest	Crop yield forecasting, drought prediction, crop segmentation using remote sensing
SDG 3	Good Health & Well-Being	SVM, Random Forest, LSTM, CNN (medical imaging)	Disease outbreak prediction, mortality modeling, patient risk scoring
SDG 4	Quality Education	Logistic Regression, Random Forest, NLP classifiers	Predicting student performance, analyzing education policies, dropout prediction
SDG 5	Gender Equality	NLP (BERT), Sentiment Analysis, Topic Modeling	Gender policy analysis, online discourse analysis, detecting gender bias
SDG 6	Clean Water & Sanitation	SVM, Random Forest, UNet (water body detection)	Water quality prediction, flood mapping, sanitation risk assessment
SDG 7	Affordable & Clean Energy	LSTM, ARIMA, Reinforcement Learning	Energy load forecasting, smart grid optimization, renewable energy balancing
SDG 8	Decent Work & Economic Growth	Time-series forecasting, Random Forest, Clustering	GDP forecasting, unemployment prediction, economic trend detection
SDG 9	Industry, Innovation & Infrastructure	Graph Neural Networks, Reinforcement Learning	Infrastructure optimization, traffic flow prediction, smart manufacturing
SDG 10	Reduced Inequalities	Random Forest, BERT (policy text), Clustering	Income inequality modeling, migration analysis, social media monitoring
SDG 11	Sustainable Cities & Communities	GeoAI (UNet, YOLO), Agent-Based Models, RL	Urban planning, traffic optimization, housing segmentation
SDG 12	Responsible Consumption & Production	LSTM, Decision Trees, NLP (sustainability reporting)	Waste prediction, supply chain optimization, ESG text analysis
SDG 13	Climate Action	LSTM, Prophet, UNet, Climate Transformers	Climate forecasting, flood/heatwave prediction, environmental modeling
SDG 14	Life Below Water	CNN, UNet, YOLO, Random Forest	Marine litter detection, coral reef mapping, ocean pollution analysis
SDG 15	Life on Land	CNN, Random Forest, Change Detection Networks	Deforestation monitoring, biodiversity detection, land-use change
SDG 16	Peace, Justice & Institutions	NLP (BERT, GPT), Topic Modeling, Social Media AI	Conflict early-warning, hate speech tracking, governance text analysis
SDG 17	Partnerships for the Goals	Knowledge Graphs, NLP models, Network Analysis	Mapping SDG partnerships, analyzing global reports, tracking cooperation networks

NLP MODELS (TEXT ANALYTICS FOR SDGS)

Model/Method	SDG Applications
Topic Modeling (LDA, NMF)	Tracking SDG priorities across countries
Text Classification (BERT, RoBERTa)	Classifying news/articles by SDG
Sentiment Analysis (Transformers)	Gender equality perceptions (SDG 5), public opinion on climate (SDG 13)
Named Entity Recognition (NER)	Extracting SDG-related indicators from policy documents

RECOMMENDATIONS

- Invest in open data platforms
- Build local ML and data science capacity
- Develop ethical frameworks for AI and big data
- Integrate big data into SDG reporting systems

CONCLUSION

- Big data provides unparalleled opportunities to monitor, forecast, and evaluate SDGs, enabling data-driven decision-making that accelerates global development goals

Thank you for attention