Iran Water and Power Resources Development company (IWPCO)
Iran Water Resources Management company (IWRMC)
unesco Centre Under the auspices of UNESCO
RCUWM TEHRAN Regional Centre on Urban Water Management (RCUWM - Tehran)
سازمان هواشناسی کشور I. R. OF IRAN METEOROLOGICAL ORGANIZATION
WORLD METEOROLOGICAL ORGANIZATION

Regional Training Workshop on
“Teleconnections, Forecasting and Early Warning Systems ”
September 16, 2026

The Challenge of Temporal Mismatch Between the Time Horizon of Climate Forecasts and the Decision-Making Horizon in Water Resources Management under an Extreme El Niño Scenario in 2026

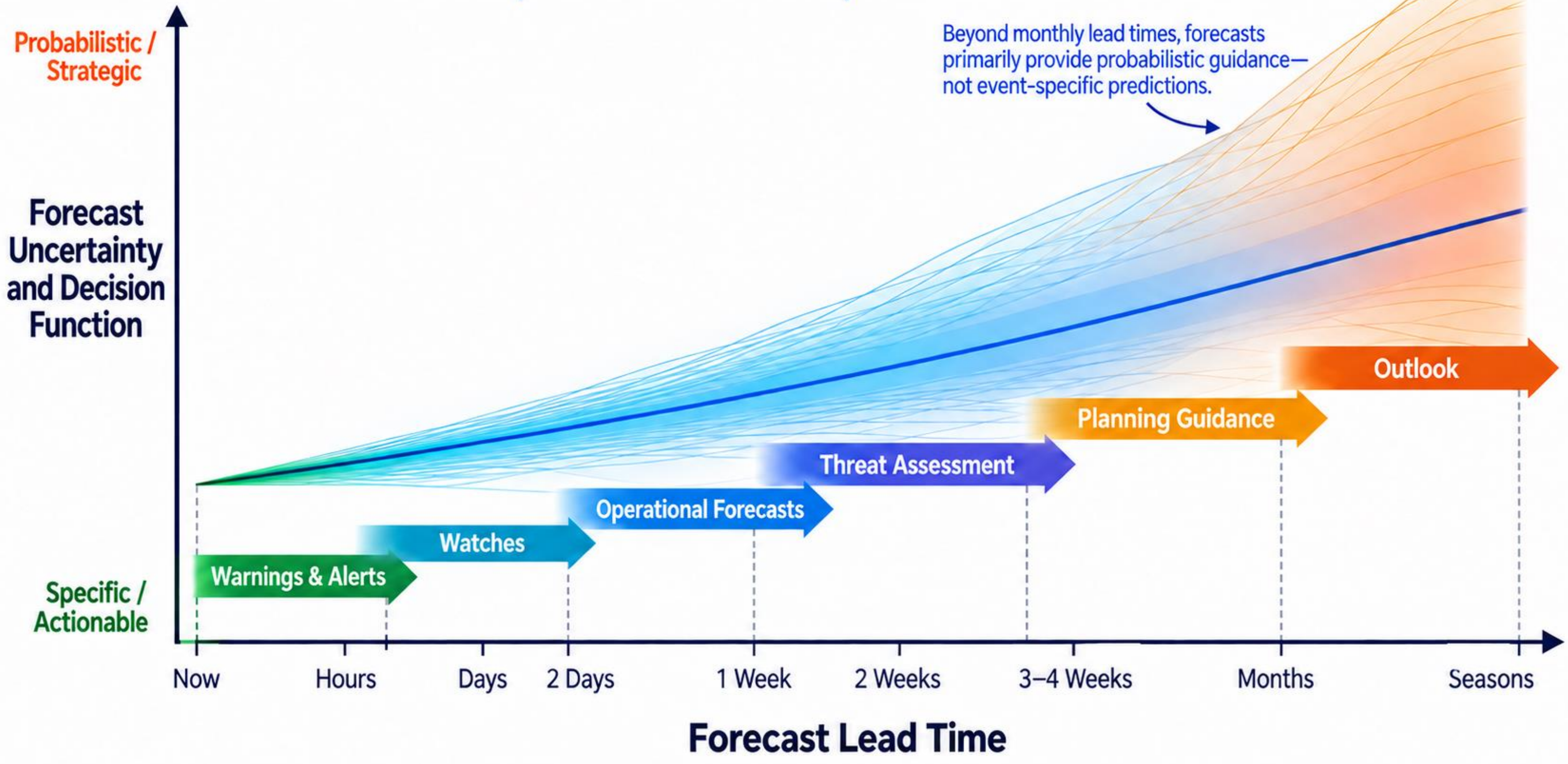
چالش عدم انطباق افق پیش بینی های اقلیمی با افق تصمیم گیری در مدیریت منابع آب در سناریو النینو حدی سال ۱۴۰۵

Dr. Ali Shahbazi
Deputy Director for Comprehensive Water Resources Studies, Khuzestan Water and Power Authority (KWPA)

سازمان آب و برق خوزستان

Forecast Uncertainty Increases with Lead Time

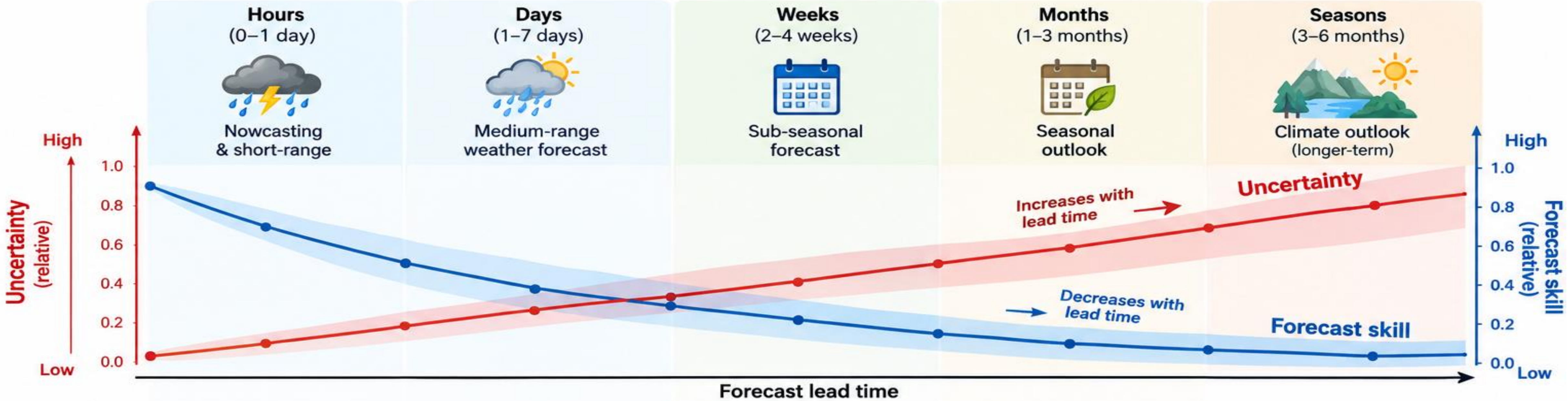
Forecast spread widens as the prediction horizon extends

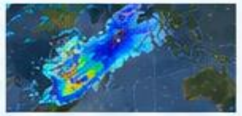
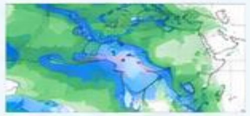
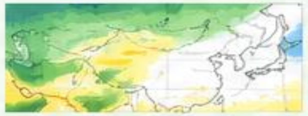
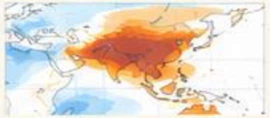
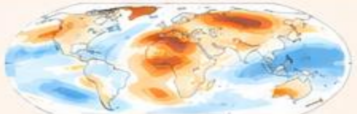


Longer Lead Time, Higher Uncertainty, Lower Skill

From weather forecasts to hydrological decisions

More time
More uncertainty
Smarter risk management

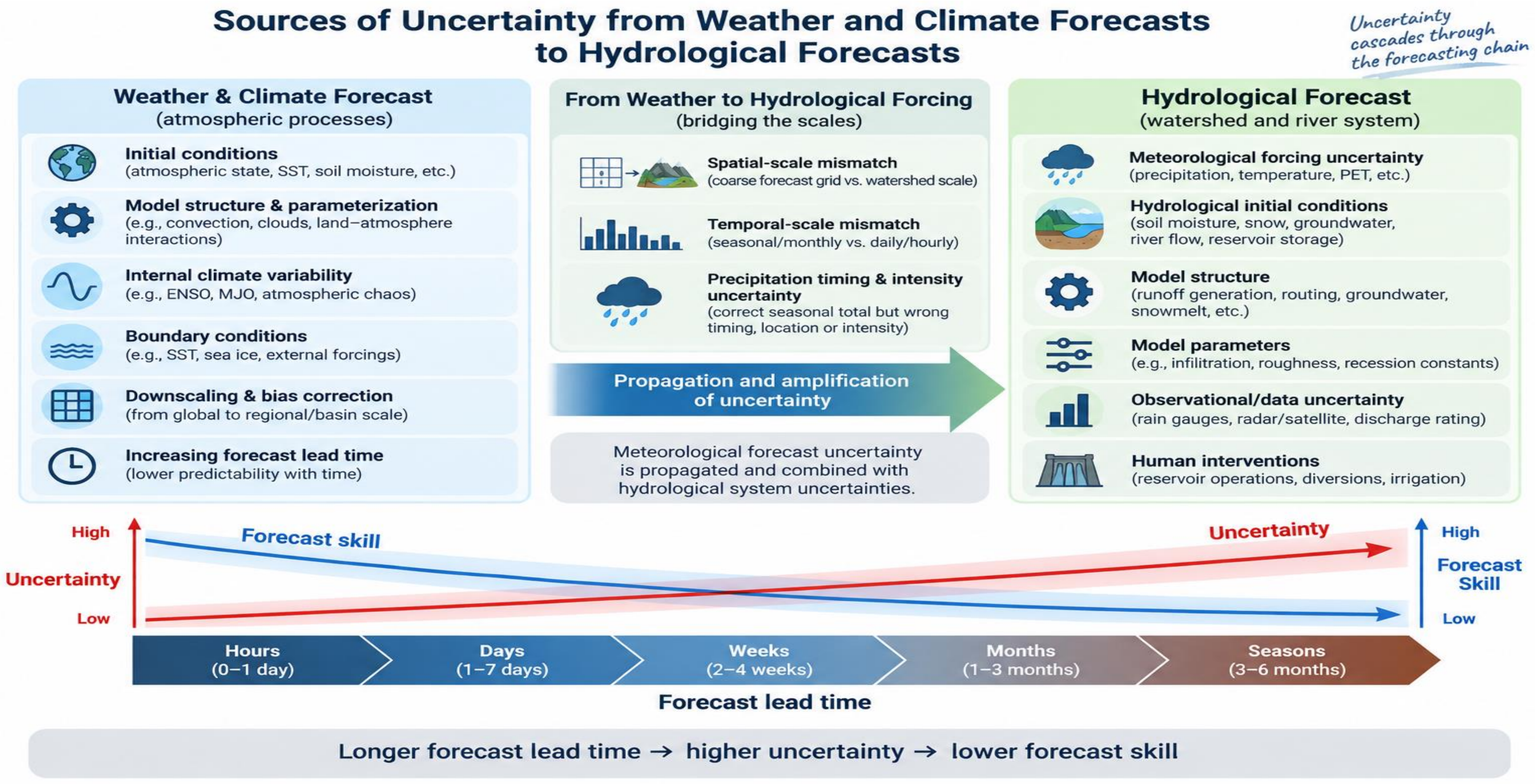


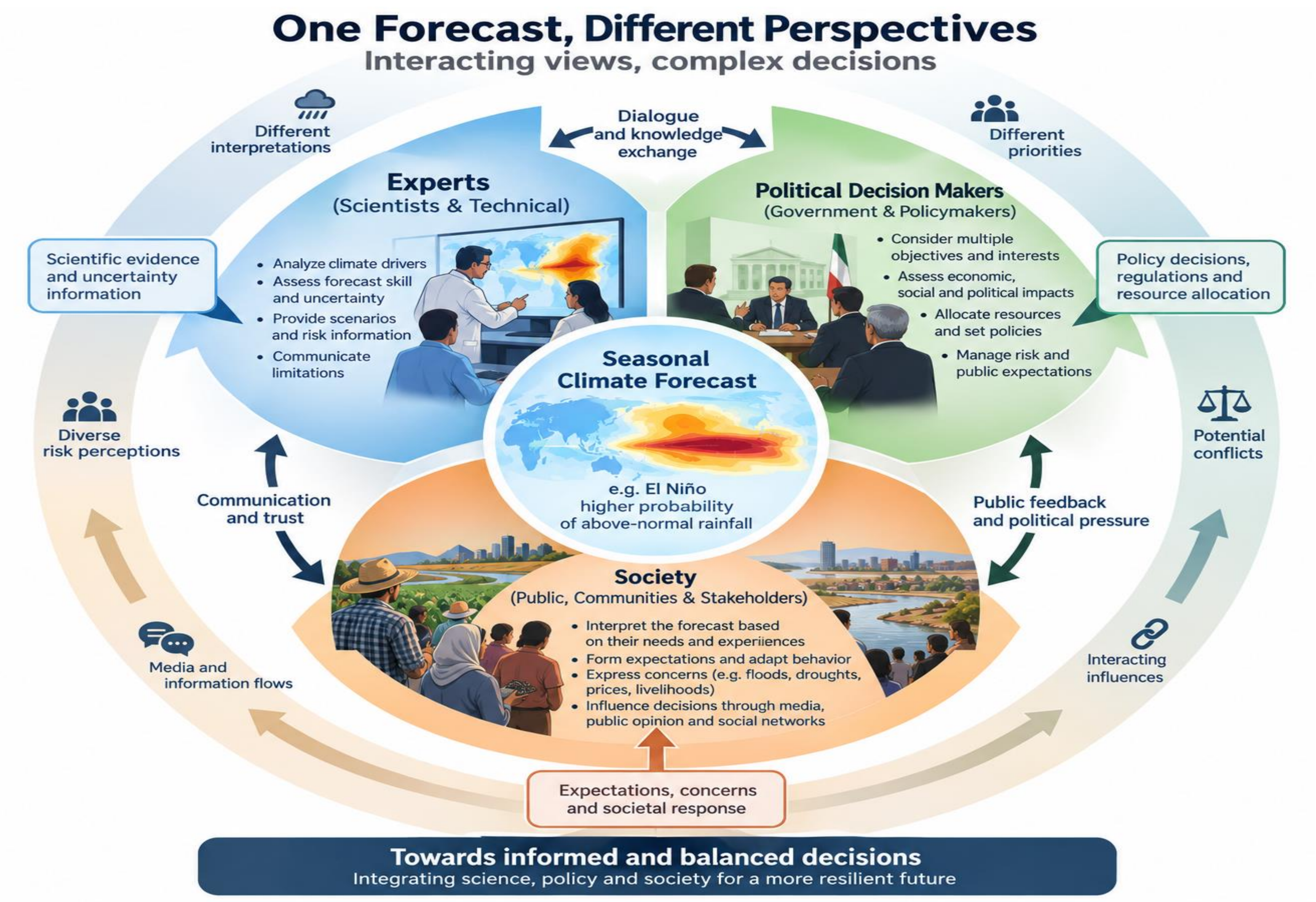
	Hours	Days	Weeks	Months	Seasons
Typical example (precipitation)	 Hourly rainfall forecast	 7-day rainfall forecast	 Week 3–4 precipitation anomaly	 Seasonal precipitation outlook	 Multi-season/climate outlook
Main use in water management	• Warnings • Real-time operations • Flood response	• Short-term operations • Reservoic releases • Flood/drought management	• Early planning • Update scenarios • Adaptive management	• Allocation planning • Crop pattern decisions • Risk assessment	• Strategic planning • Infrastructure development • Long-term resilience
Notes	Highest skill Lowest uncertainty Most actionable	Good skill Increasing uncertainty	Moderate skill Significant uncertainty Use as guidance	Low skill High uncertainty Use for scenario analysis	Very low skill Very high uncertainty Only for long-term guidance

As the forecast horizon extends from days to seasons, uncertainty increases and forecast skill decreases, requiring a shift from operational response to risk-based and adaptive decision-making.

Uncertainty is a challenge
Better decisions are a choice

Cascading Uncertainty in the Forecasting Chain





One Forecast, Different Perspectives
Interacting views, complex decisions
Different interpretations
Dialogue and knowledge exchange
Different priorities
Experts
(Scientists & Technical)
Analyze climate drivers
Assess forecast skill and uncertainty
Provide scenarios and risk information
Communicate limitations
Scientific evidence and uncertainty information
Political Decision Makers
(Government & Policymakers)
Consider multiple objectives and interests
Assess economic, social and political impacts
Allocate resources and set policies
Manage risk and public expectations
Policy decisions, regulations and resource allocation
Seasonal Climate Forecast
e.g. El Niño higher probability of above-normal rainfall
Diverse risk perceptions
Communication and trust
Potential conflicts
Public feedback and political pressure
Society
(Public, Communities & Stakeholders)
Interpret the forecast based on their needs and experiiences
Form expectations and adapt behavior
Express concerns (e.g. floods, droughts, prices, livelihoods)
Influence decisions through media, public opinion and social networks
Media and information flows
Interacting influences
Expectations, concerns and societal response
Towards informed and balanced decisions
Integrating science, policy and society for a more resilient future

Khuzestan Province

At the Heart of Iran's Water System

Water for People, Agriculture and a Prosperous Tomorrow

Karun River, Ahvaz
A resilient land
A shared future

River Basin Boundary
Khuzestan Province Boundary

N

5.1 million
Population in Khuzestan Province

Located in the downstream of 3 major river basins
Karkheh, Greater Karun, and Zohreh–Jarrahi

A major agricultural hub
A key contributor to the country's food security

> 93%
of the province's water needs are supplied from surface water

Regulated by the country's largest reservoir system
with a total storage capacity of **> 23.5 billion cubic meters**

Long-term average inflow 25 – 28 billion cubic meters
with extreme variations from 10 to 50 billion cubic meters

Water distribution and management
through an extensive river network of **> 11,000 kilometers**

Highlights the importance of hydro-climatic forecasts
in managing floods, droughts and food security

Agriculture
Fertile lands, greater food security

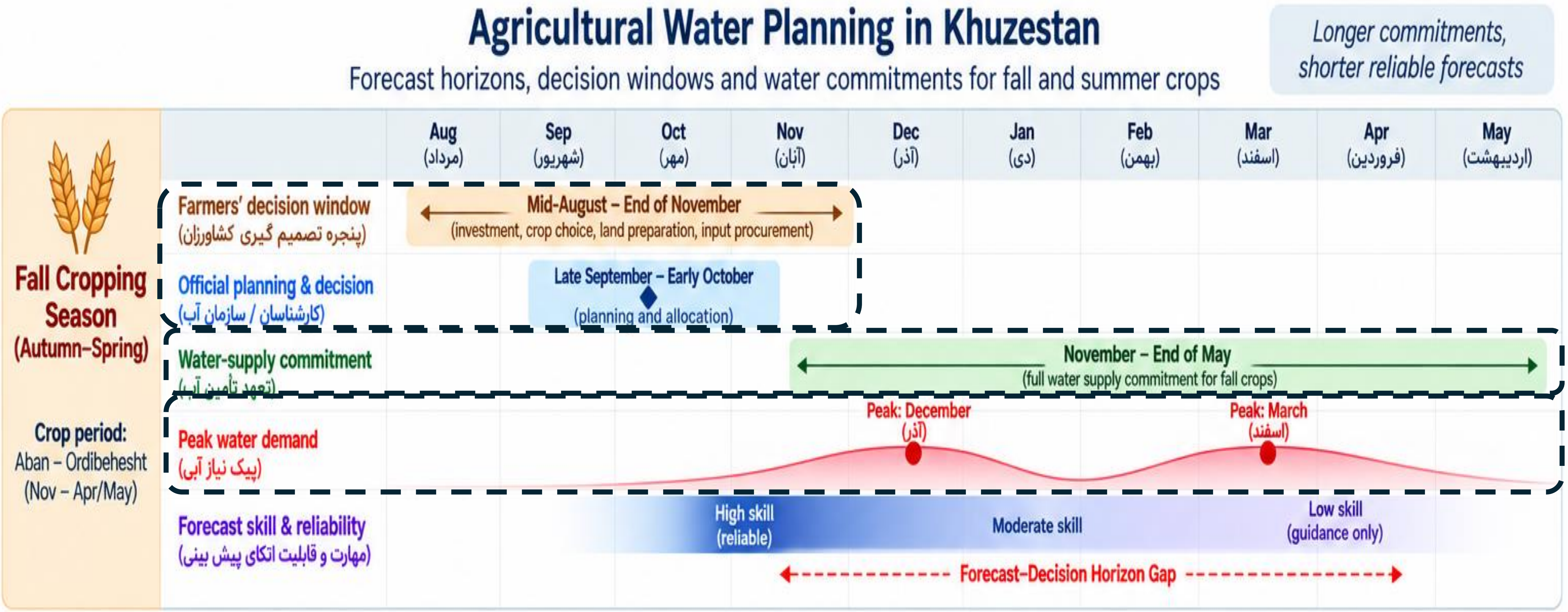
Industry
Driving regional development

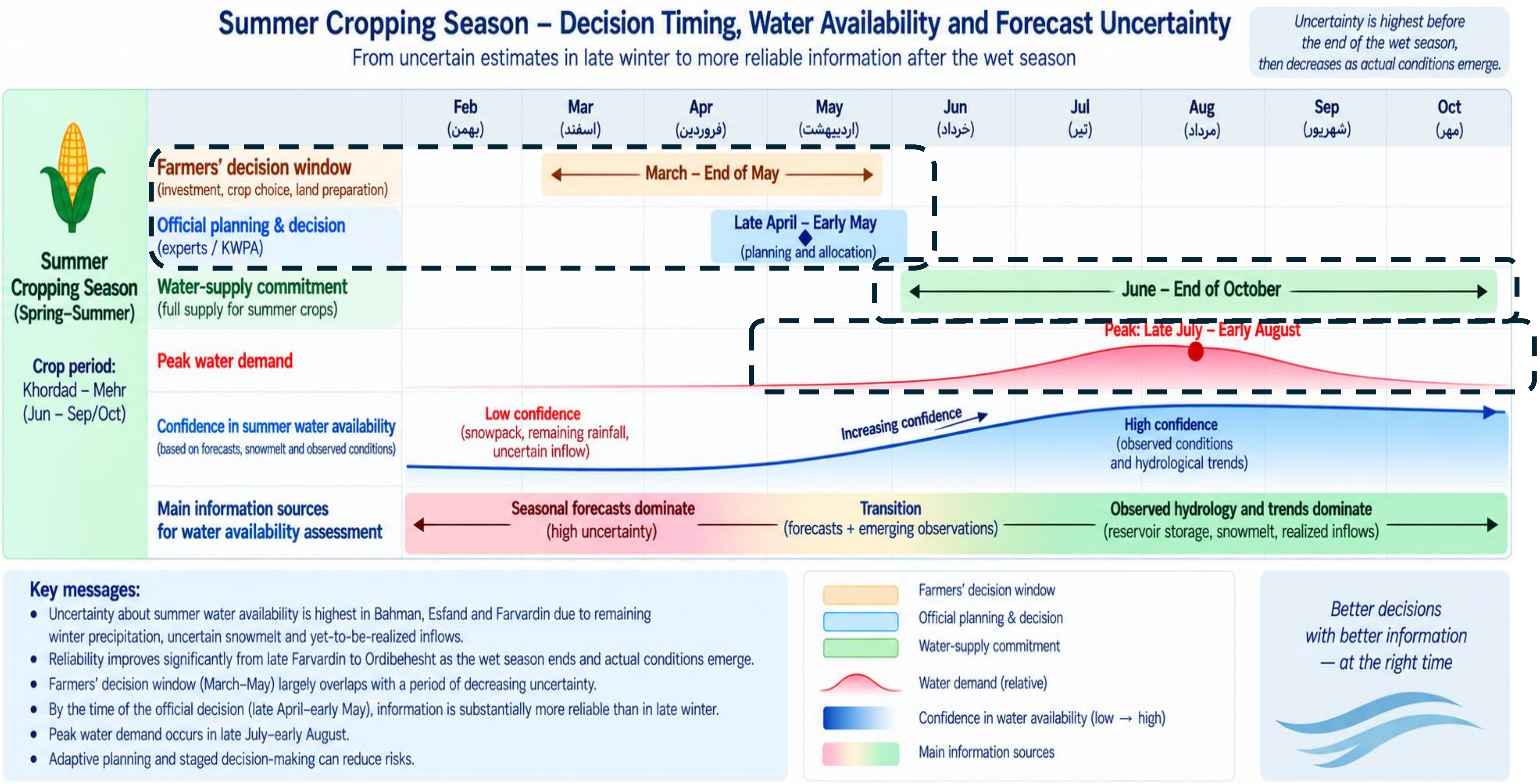
Wetlands
Valuable ecosystems

People and Cities
A dynamic and resilient society

Khuzestan Water & Power Authority
Comprehensive Water Resources Studies

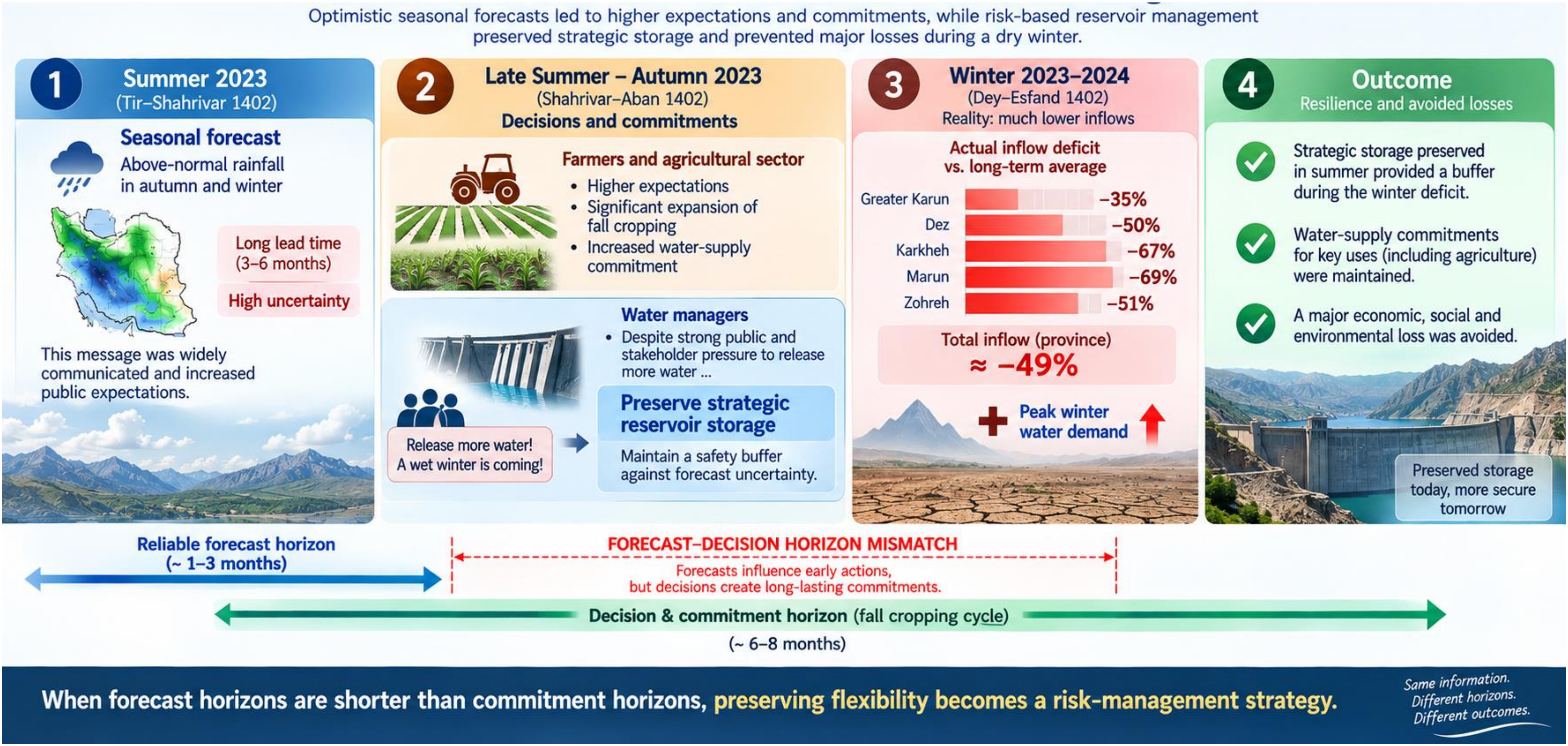
From the Zagros to the Persian Gulf
A Shared Tomorrow


Agricultural Water Planning in Khuzestan
Forecast horizons, decision windows and water commitments for fall and summer crops
Longer commitments, shorter reliable forecasts
Aug (مرداد)
Sep (شهریور)
Oct (مهر)
Nov (آبان)
Dec (آذر)
Jan (دی)
Feb (بهمن)
Mar (اسفند)
Apr (فروردین)
May (اردیبهشت)
Fall Cropping Season (Autumn–Spring)
Crop period: Aban – Ordibehesht (Nov – Apr/May)
Farmers' decision window (پنجره تصمیم گیری کشاورزان)
Mid-August – End of November
(investment, crop choice, land preparation, input procurement)
Official planning & decision (کارشناسان / سازمان آب)
Late September – Early October
(planning and allocation)
Water-supply commitment (تعهد تأمین آب)
November – End of May
(full water supply commitment for fall crops)
Peak water demand (پیک نیاز آبی)
Peak: December (آذر)
Peak: March (اسفند)
Forecast skill & reliability (مهارت و قابلیت اتکای پیش بینی)
High skill (reliable)
Moderate skill
Low skill (guidance only)
Forecast-Decision Horizon Gap



Summer Cropping Season – Decision Timing, Water Availability and Forecast Uncertainty
From uncertain estimates in late winter to more reliable information after the wet season
Uncertainty is highest before the end of the wet season, then decreases as actual conditions emerge.
Feb (بهمن)
Mar (اسفند)
Apr (فروردین)
May (اردیبهشت)
Jun (خرداد)
Jul (تیر)
Aug (مرداد)
Sep (شهریور)
Oct (مهر)
Summer Cropping Season (Spring–Summer)
Crop period: Khordad – Mehr (Jun – Sep/Oct)
Farmers' decision window
(investment, crop choice, land preparation)
March – End of May
Official planning & decision
(experts / KWPA)
Late April – Early May
(planning and allocation)
Water-supply commitment
(full supply for summer crops)
June – End of October
Peak water demand
Peak: Late July – Early August
Confidence in summer water availability
(based on forecasts, snowmelt and observed conditions)
Low confidence
(snowpack, remaining rainfall, uncertain inflow)
Increasing confidence
High confidence
(observed conditions and hydrological trends)
Main information sources for water availability assessment
Seasonal forecasts dominate
(high uncertainty)
Transition
(forecasts + emerging observations)
Observed hydrology and trends dominate
(reservoir storage, snowmelt, realized inflows)
Key messages:
Uncertainty about summer water availability is highest in Bahman, Esfand and Farvardin due to remaining winter precipitation, uncertain snowmelt and yet-to-be-realized inflows.
Reliability improves significantly from late Farvardin to Ordibehesht as the wet season ends and actual conditions emerge.
Farmers' decision window (March–May) largely overlaps with a period of decreasing uncertainty.
By the time of the official decision (late April–early May), information is substantially more reliable than in late winter.
Peak water demand occurs in late July–early August.
Adaptive planning and staged decision-making can reduce risks.
Farmers' decision window
Official planning & decision
Water-supply commitment
Water demand (relative)
Confidence in water availability (low → high)
Main information sources
Better decisions with better information — at the right time

Fall 2023: When Forecasts, Decisions and reality don’t align



Winter 2024 (1404): A Real Example of Forecast–Decision Horizon Mismatch

A critical decision under severe drought, followed by an unexpected spring recovery

Uncertain forecasts.
Difficult decisions.
Real-world outcomes.

1 Prolonged drought (18 months)

Very low inflows and declining reservoir storage before winter 2024 (1404)

Inflow to dams (Mehr 1403 – Esfand 1404)

6,286 MCM
(6.29 BCM)

47% below long-term average (11,790 MCM)

2 Winter 2024 (Esfand 1404) The decision under uncertainty

Peak water demand for fall crops, with reservoirs at critical levels

Supply fall crops
Prevent severe damage to current production
Requires releasing more water

Preserve storage
Reduce the risk of summer water shortage (for drinking water, environment, etc.)
Requires restricting releases

Risk-based decision
Integrating multiple sources of information

- Seasonal weather forecasts (probabilistic)
- ESP inflow forecasting (hydrological)
- Markov chain analysis (stochastic)

3 Forecast–Decision Horizon Mismatch

The decision had to be made in winter, while spring inflows were still unknown and not well captured by seasonal forecasts.

Decision point (Esfand 1404) — Today

Spring inflow (unknown at decision time) — Farvardin–Ordibehesht 1405

Key information not yet available

The magnitude of spring inflows was not indicated by the seasonal forecast models.

4 What actually happened?

A major spring recovery, far larger than expected

Previous 6 months (Mehr 1403 – Esfand 1404)

6,286 MCM (6.29 BCM)

Karun (e.g. Gotvand)	3,313
Dez	1,711
Karkheh	816
Marun	388
Jarahi	58
Total	**6,286**

≈ 2.6× higher inflow in just two months

Spring (2 months) (Farvardin–Ordibehesht 1405)

16,379 MCM (16.38 BCM)

Karun (e.g. Gotvand)	7,411
Dez	4,734
Karkheh	3,228
Marun	874
Jarahi	133
Total	**16,379**

Spring inflow in just two months was about 2.6 times the total inflow of the previous six months.

Reliable forecast horizon (~ 1–3 months)

FORECAST–DECISION HORIZON MISMATCH
Decisions had to be made months before the actual spring inflows were known.

Decision and commitment horizon (fall cropping season)
~ 5–7 months (planting → peak demand → harvest)

The critical decision had to be made before the most important hydrological information became observable.
Forecasts inform the decision. Risk management bridges the uncertainty.

Different horizons.
More resilient water management.

From Forecasts to Action

Integrated Forecasting and Risk-Based Water Management for Khuzestan

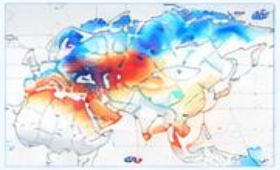
Anticipate
Adapt
Build a More Resilient Khuzestan

1. Multiple Forecasting Inputs

Complementary sources for future inflow estimation

Seasonal Climate Forecasts

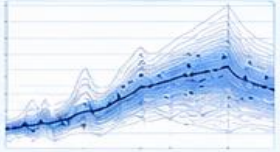
- Global & regional models (e.g. ECMWF, NMME)
- Precipitation and temperature outlooks
- Downscaling to the basin



Seasonal precipitation anomaly (e.g. NMME)

ESP (Ensemble Streamflow Prediction)

- Using historical meteorological sequences
- Accounts for natural variability
- Generates probabilistic streamflow forecasts



ESP from historical records

Markov-Chain Analysis

- Based on historical inflow sequences
- Captures persistence and transition probabilities
- Generates complementary inflow scenarios

Transition Probabilities

Forecasting information

2. Integrated Inflow Scenario Generation

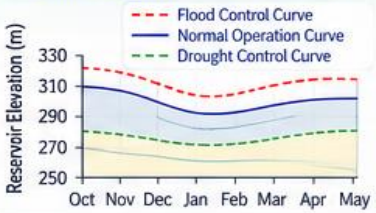
Combining forecasts and system knowledge

Hydrological Modeling

- NAM (National Applied Model)
- SAWT (Semi-distributed Agricultural Watershed Tool)
- Integrated simulation of basin rainfall–runoff processes

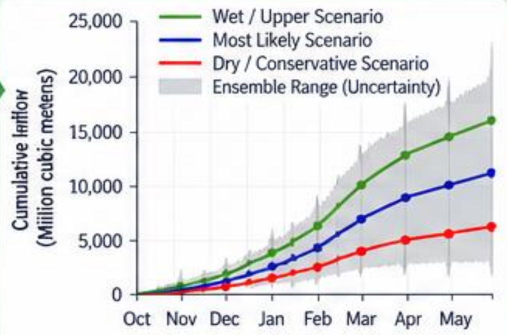
Reservoir Rule Curves and System Constraints

- Flood control, normal operation and drought control curves
- Current reservoir storage
- Downstream and environmental requirements
- Water demands (agriculture, drinking water, industry, wetlands)



Inflow Scenarios

Seasonal inflow scenarios for Khuzestan



Integrated analysis and scenario development

3. Risk-Based Water Management Plan

From scenarios to proactive and adaptive decisions

Scenario Assessment and Risk Analysis

- Evaluate flood and drought risks
- Assess water supply reliability
- Analyze socio-economic and environmental impacts

Management Strategy Development

- Determine seasonal reservoir releases
- Allocation to water uses (agriculture, drinking water, industry, environment)
- Contingency measures
- Adaptive management options

Proactive Water Resources and Demand Management in Khuzestan

People • Water • Sustainable Development

- Higher preparedness
- Reduced risks
- Efficient water allocation
- Greater resilience
- Adaptive to uncertainty

Khuzestan Water & Power Authority
Comprehensive Water Resources Studies

From Knowledge to Resilient Action


Communicating Seasonal Forecasts for Real-World Decisions
Same information. A shared understanding. A more resilient Khuzestan.
From Forecasts to Common Ground
1. A Probabilistic Seasonal Forecast
Drier
Near Normal
Wetter
e.g. Higher probability of above-normal rainfall in autumn
2. Different Interpretations Can Lead to Different Expectations
A wet year! I can expand cultivation.
A possible wet signal, but with high uncertainty.
What are the risks? How should we plan?
People (Farmers / Public)
Hope and opportunity
Experts (Technical Analysis)
Cautious assessment
Decision Makers (Planning & Policy)
Risk and trade-offs
3. Clear and Inclusive Communication
Present the full range of scenarios and uncertainty in a simple way
20%
30%
50%
Below Normal
Near Normal
Above Normal
Uncertainty is part of the message
4. A Shared Understanding for Better Decisions
Same information
A common understanding
More resilient decisions
Our goal is to align the understanding of the public, experts and decision makers
through clear visuals and suitable information, so that seasonal forecasts lead to realistic expectations and more effective, timely and widely supported decisions.
Khuzestan Water & Power Authority
Comprehensive Water Resources Studies
People • Water • A Resilient Khuzestan

CONCLUSION

Key Takeaways

From Forecasts to More Informed, Resilient Decisions

Uncertainty Today
A Stronger Tomorrow

1 Uncertainty Is Inevitable

Forecast uncertainty increases with lead time and propagates into hydrological predictions.

2 Align Decision Windows & Understanding

Provide timely information and build a shared understanding among the public, experts and decision makers.

3 Manage Risk — Not a Single Forecast

Use multiple forecasts and scenarios to evaluate risk, preserve flexibility and update decisions as new information becomes available.

4 Move from Reactive to Proactive Management

Anticipate possible futures, prepare actions in advance and adapt as conditions evolve.

THE GOAL IS NOT TO ELIMINATE UNCERTAINTY.

THE GOAL IS TO MAKE BETTER DECISIONS UNDER UNCERTAINTY.

PEOPLE • KNOWLEDGE • COLLABORATION • RESILIENT TOMORROWS

From Uncertainty to Opportunity

Thank you for your attention

Alish1980@gmail.com