



***Expert Group Meeting on Pursuing Improved
Shared Water Resources Management within the
Framework of Global and Regional Agreements
Cairo, Egypt, 29-30 November 2017***

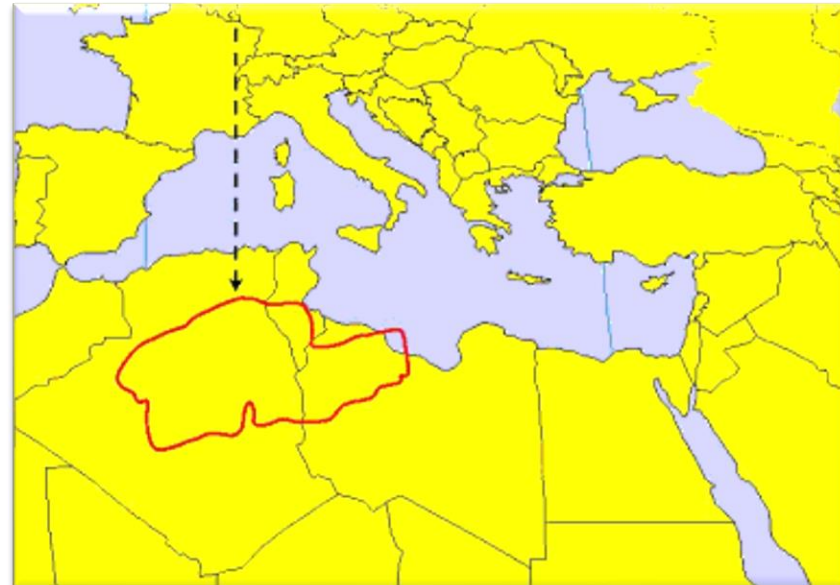
***Managing Shared Water Resources in Tunisia
Surface Water
And Groundwater Perspectives***



Badiaa Chulli

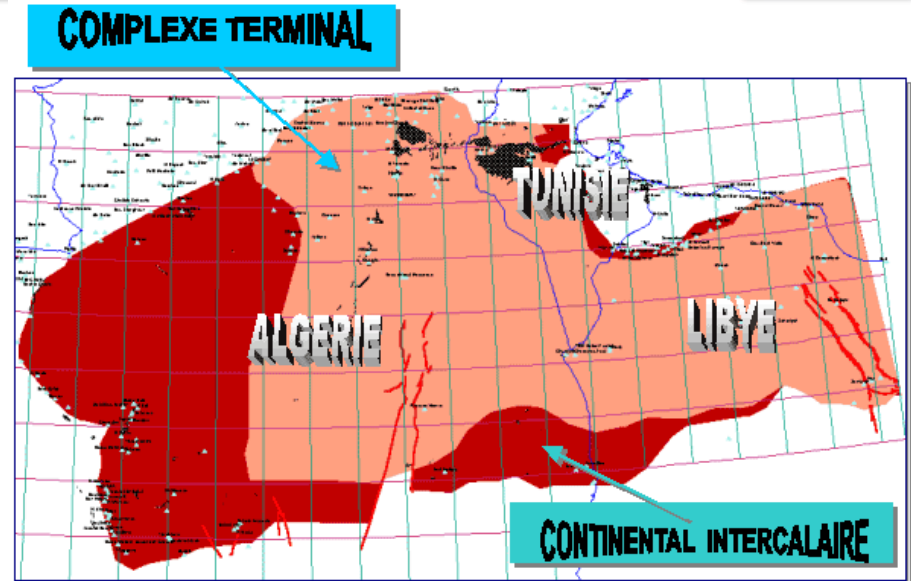
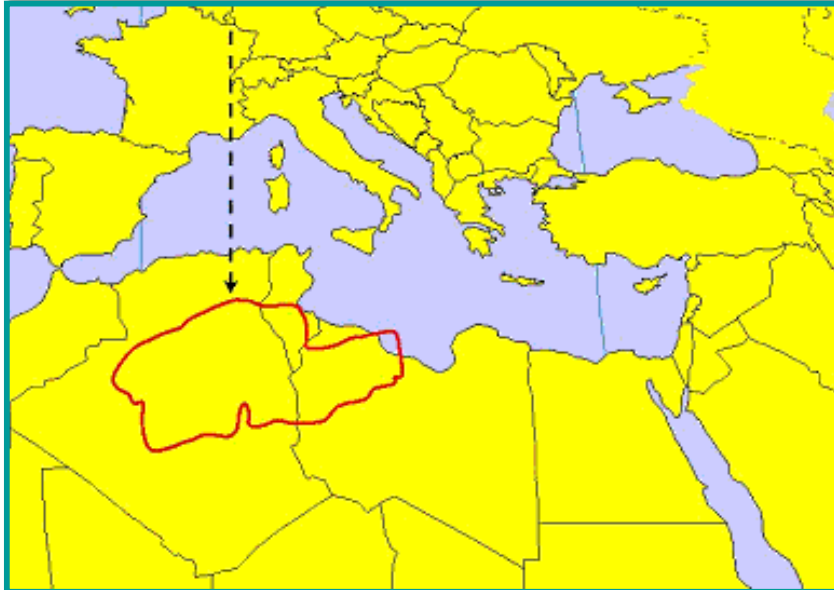
***Carthage university
Water Researches and Technologies Centre
Borj-Cedria Technopark,
BP 273, 8020 Soliman
Tunisia***

E-mail: bchoulli@yahoo.fr



The North Western Sahara Aquifer System Basin NWSAS [SASS]

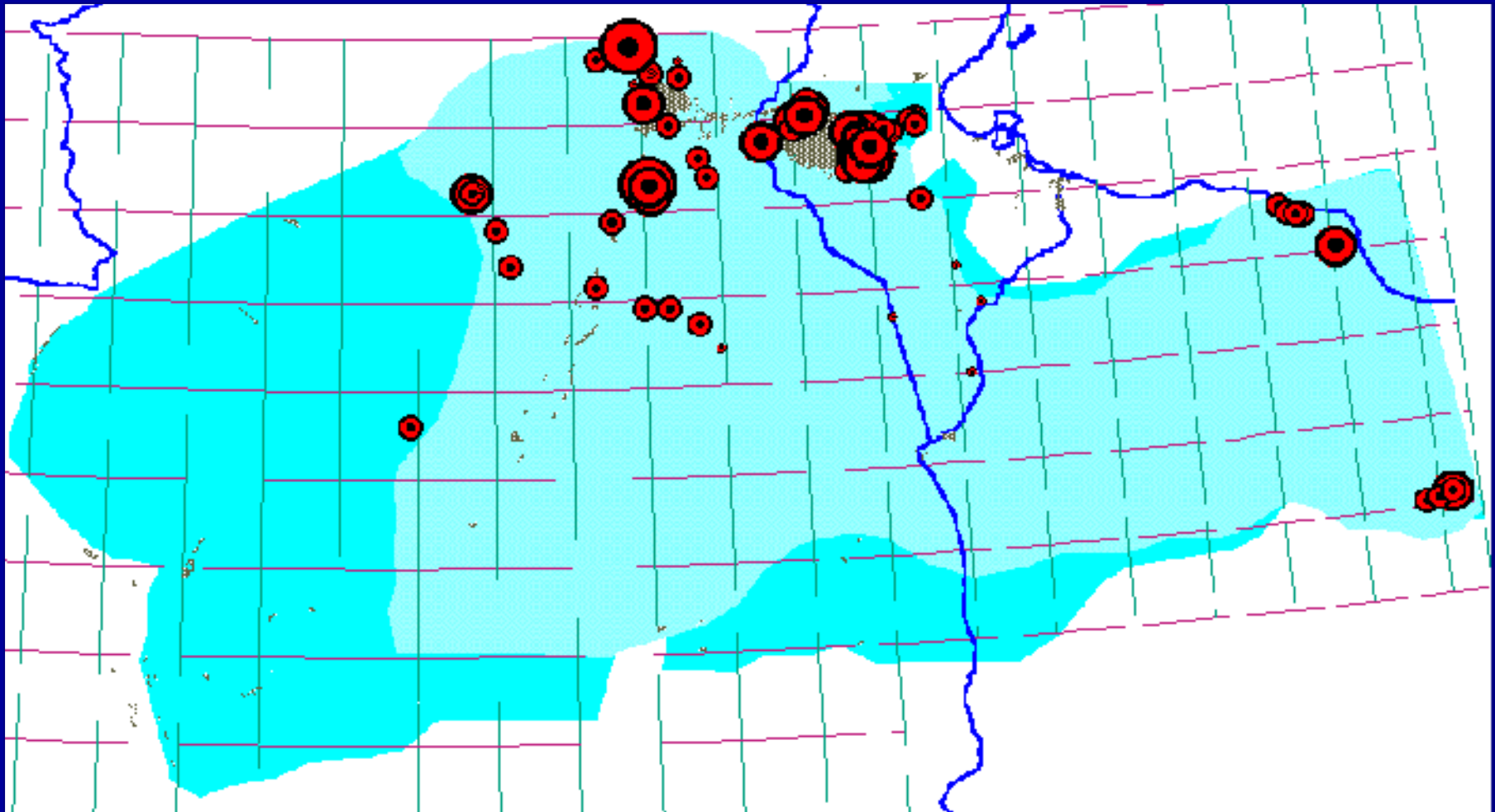
Substantial but depletable reserves



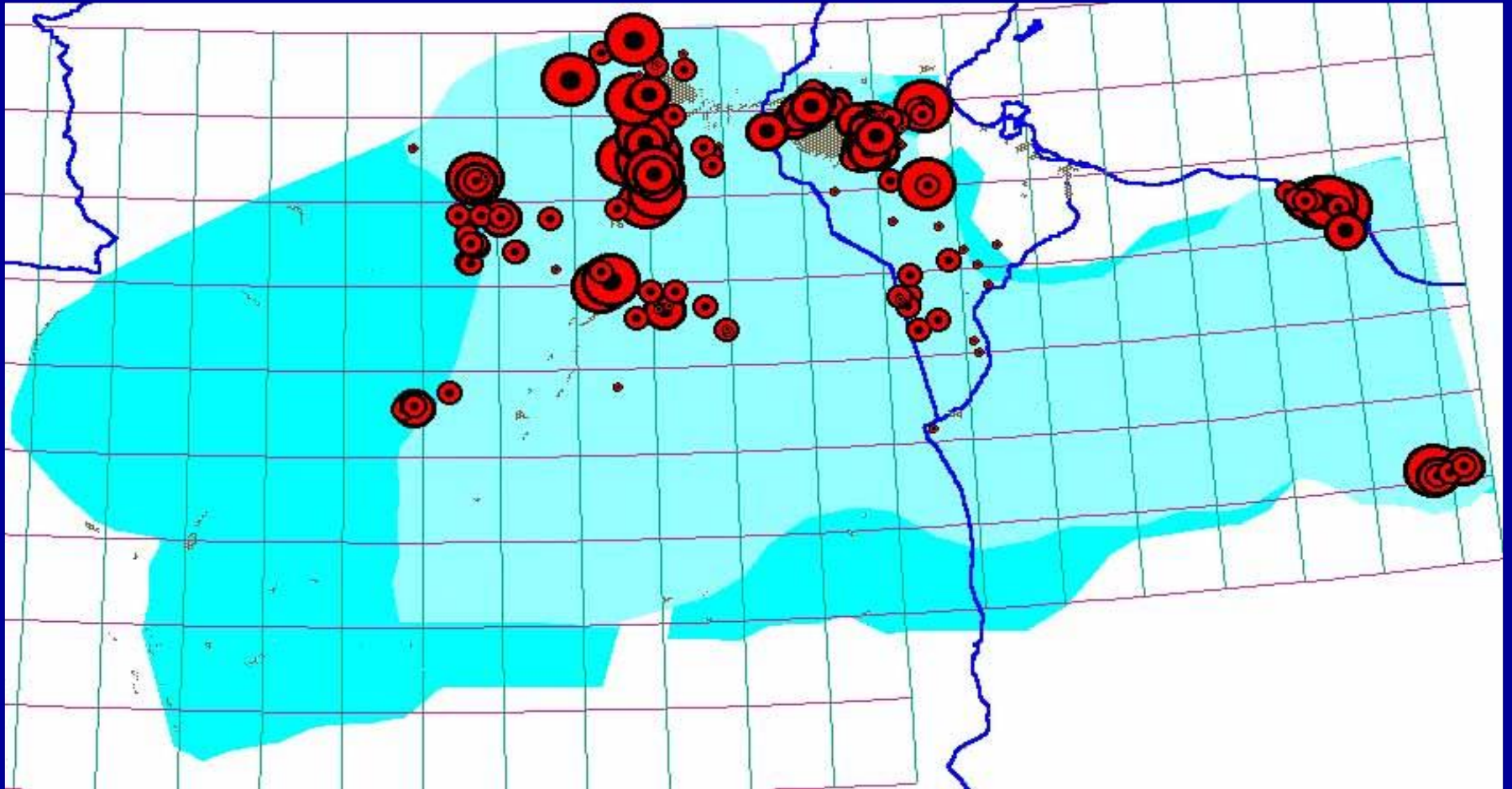
- An area of one million km² shared by three countries:
- Algeria, Tunisia and Libya
- Population: 4 million in 2000, 8 million in 2030
- Irrigated lands: 200,000 ha
- Intensively exploited resources: 2,5 billion m³/year
- Fragile ecosystem
- Vulnerable environnement

The SASS programme is an action programme for joint management of shared aquifers.

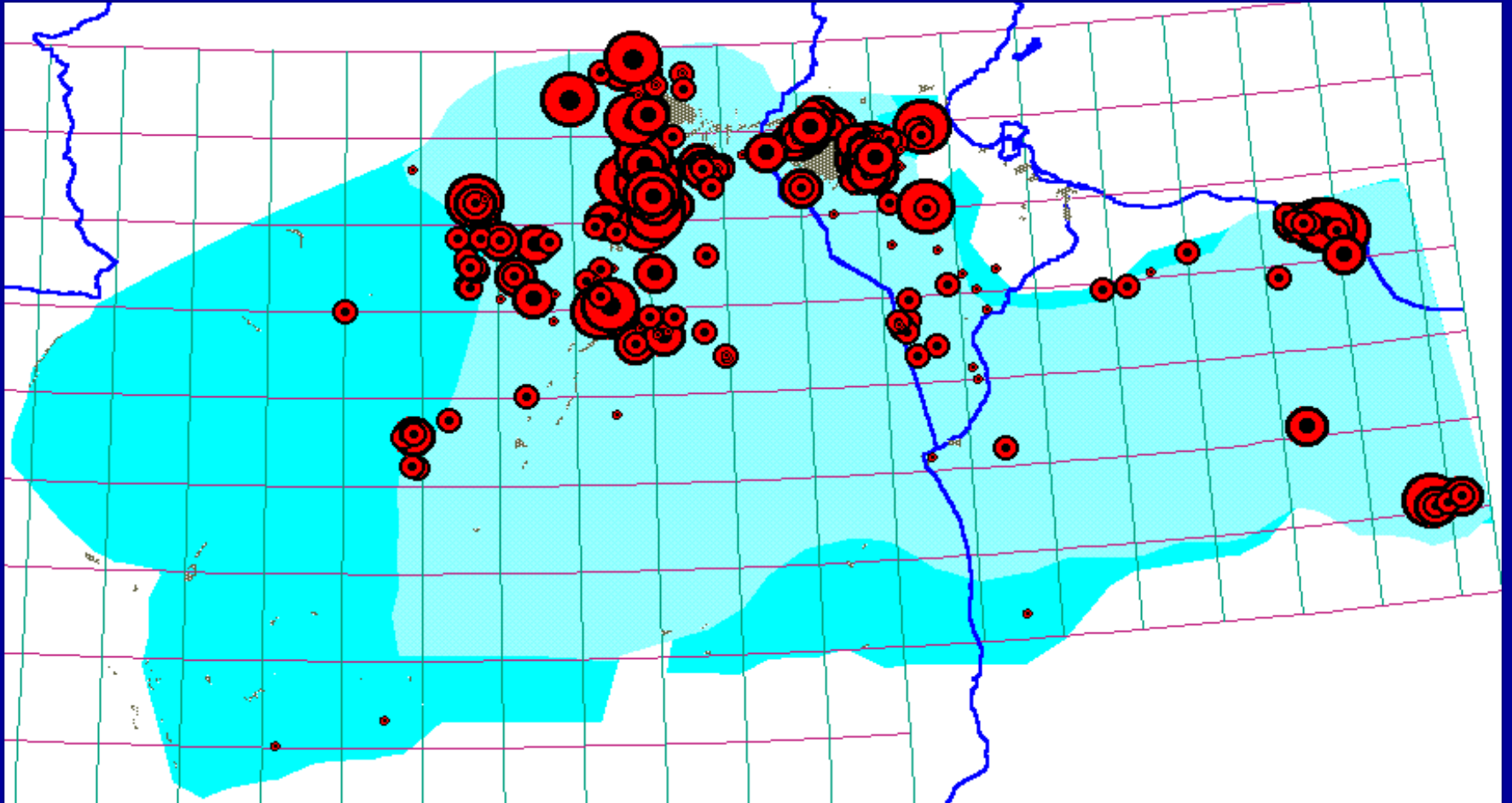
1960



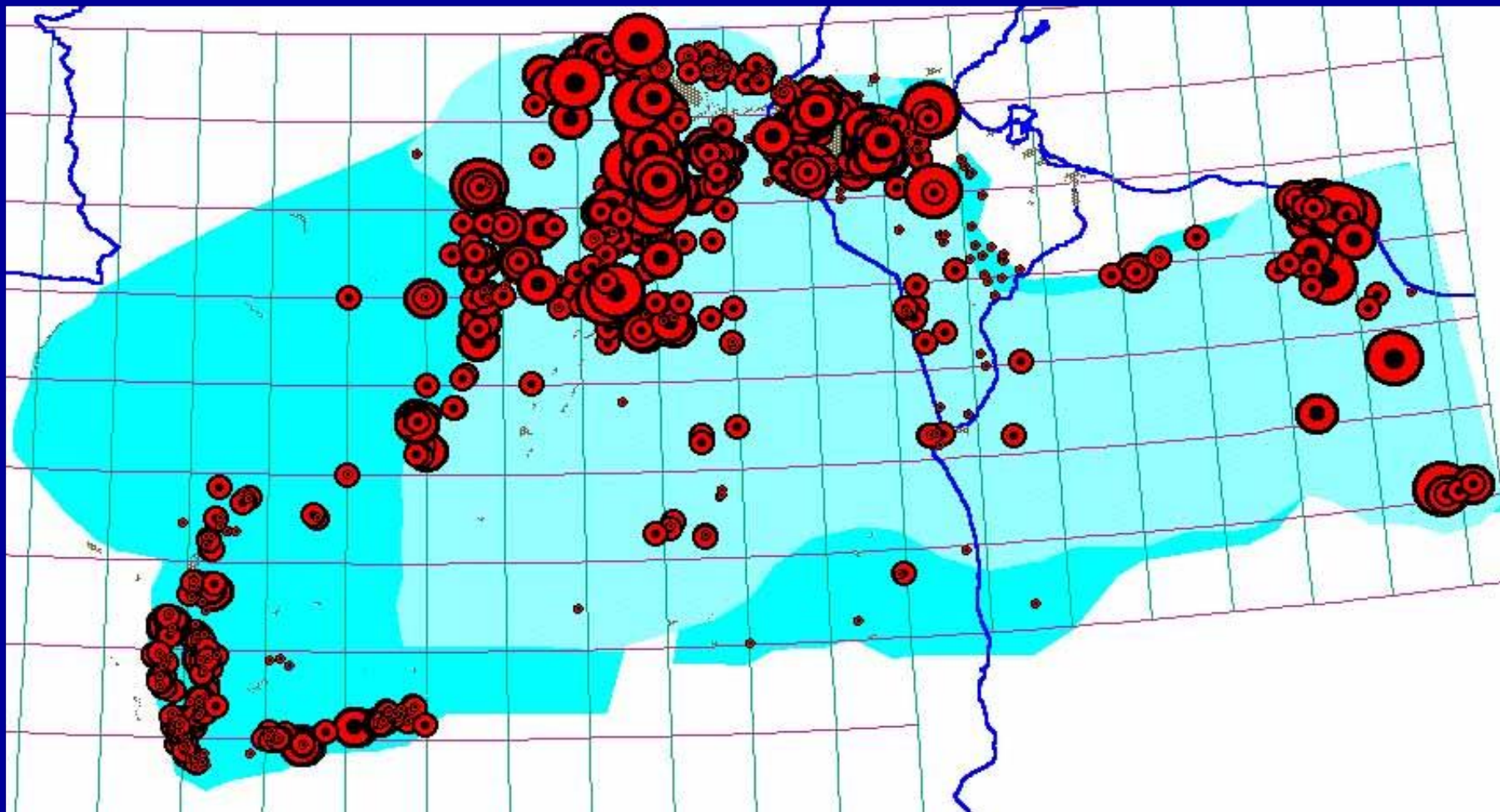
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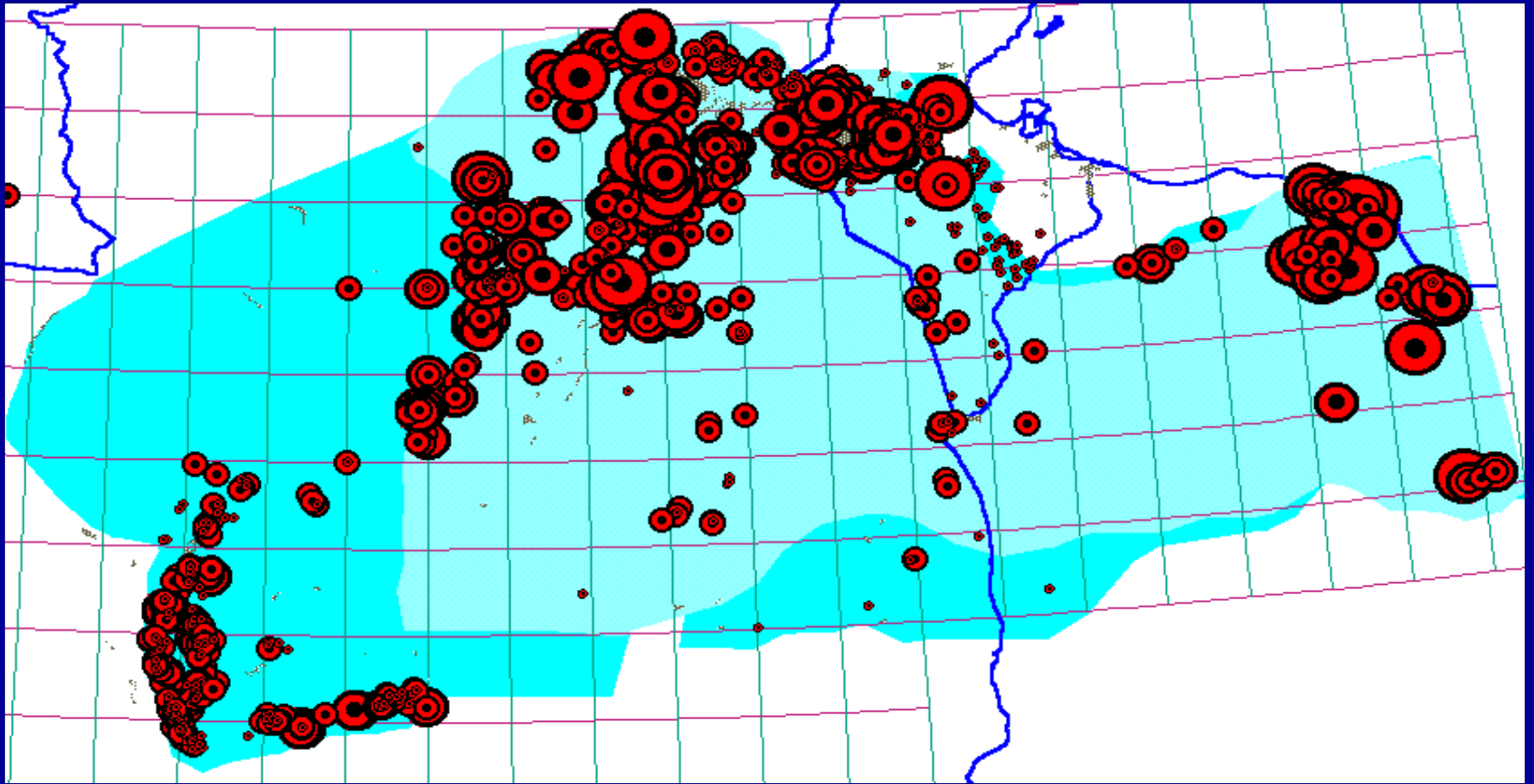
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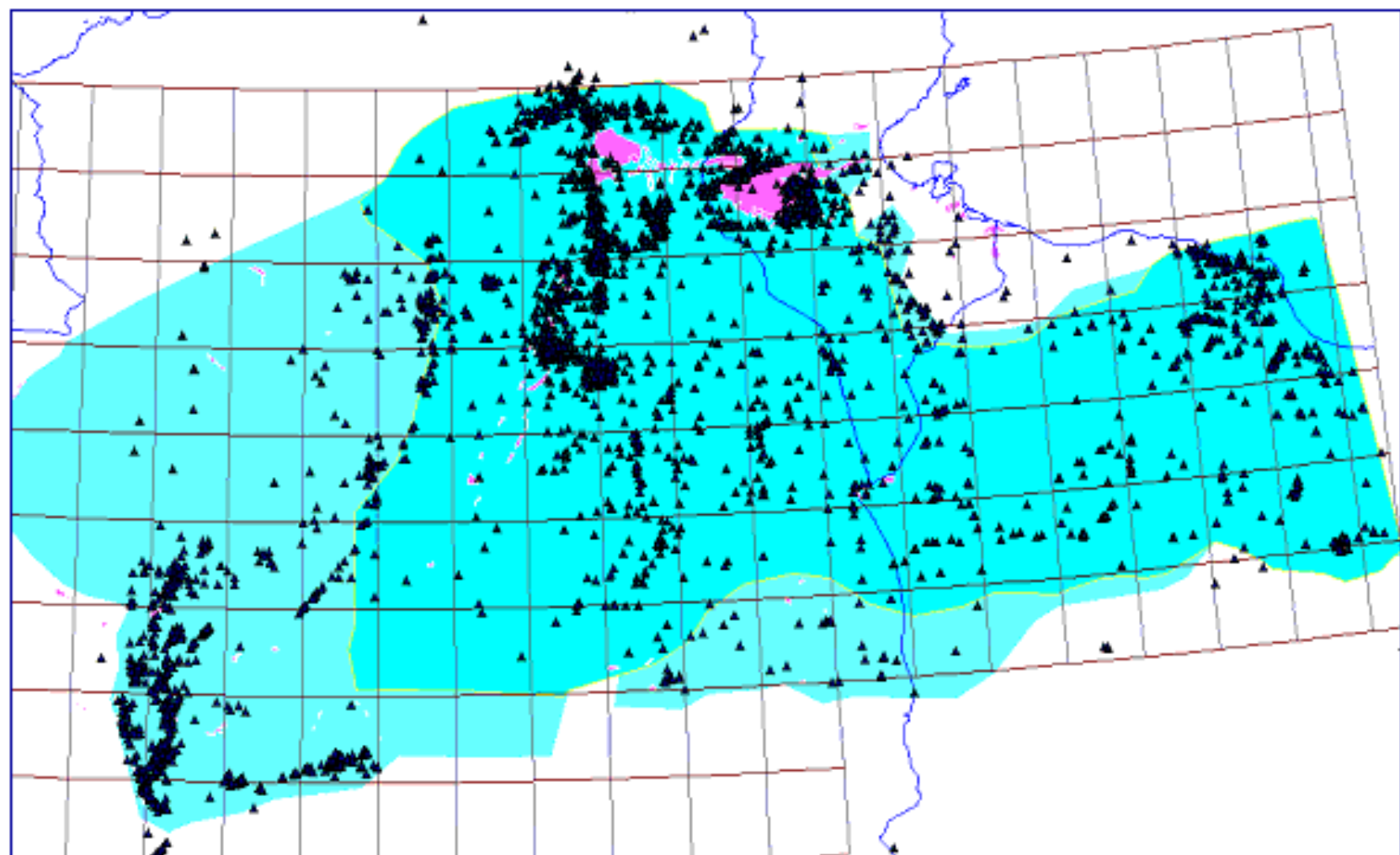


1990

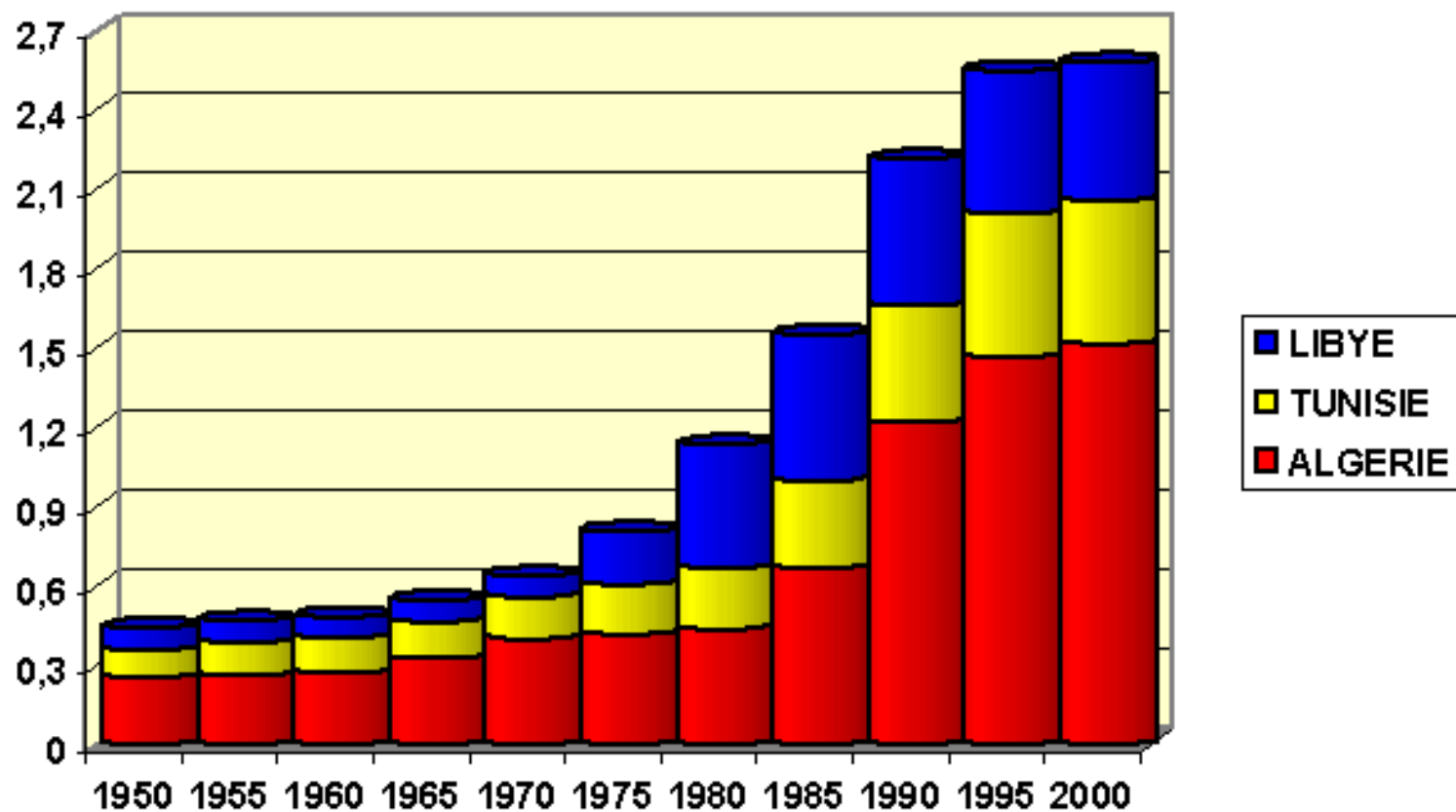


2010





Prélèvements Totaux dans les aquifères sahariens
en Milliards de m³/an



Implementation phases

Phase 1: SASS I (1999-2002)

Objectives and activities contain three components.

- A better geologic and hydrologic knowledge of the aquifer system.
- The creation of a database listing more than 9000 well drillings.
- The elaboration of a mathematical model allowing simulations and estimations.

**HYDROGEOLOGY &
INFORMATION SYSTEM**

MATHEMATICAL MODEL

CONTINENTAL INTERCALAIRE

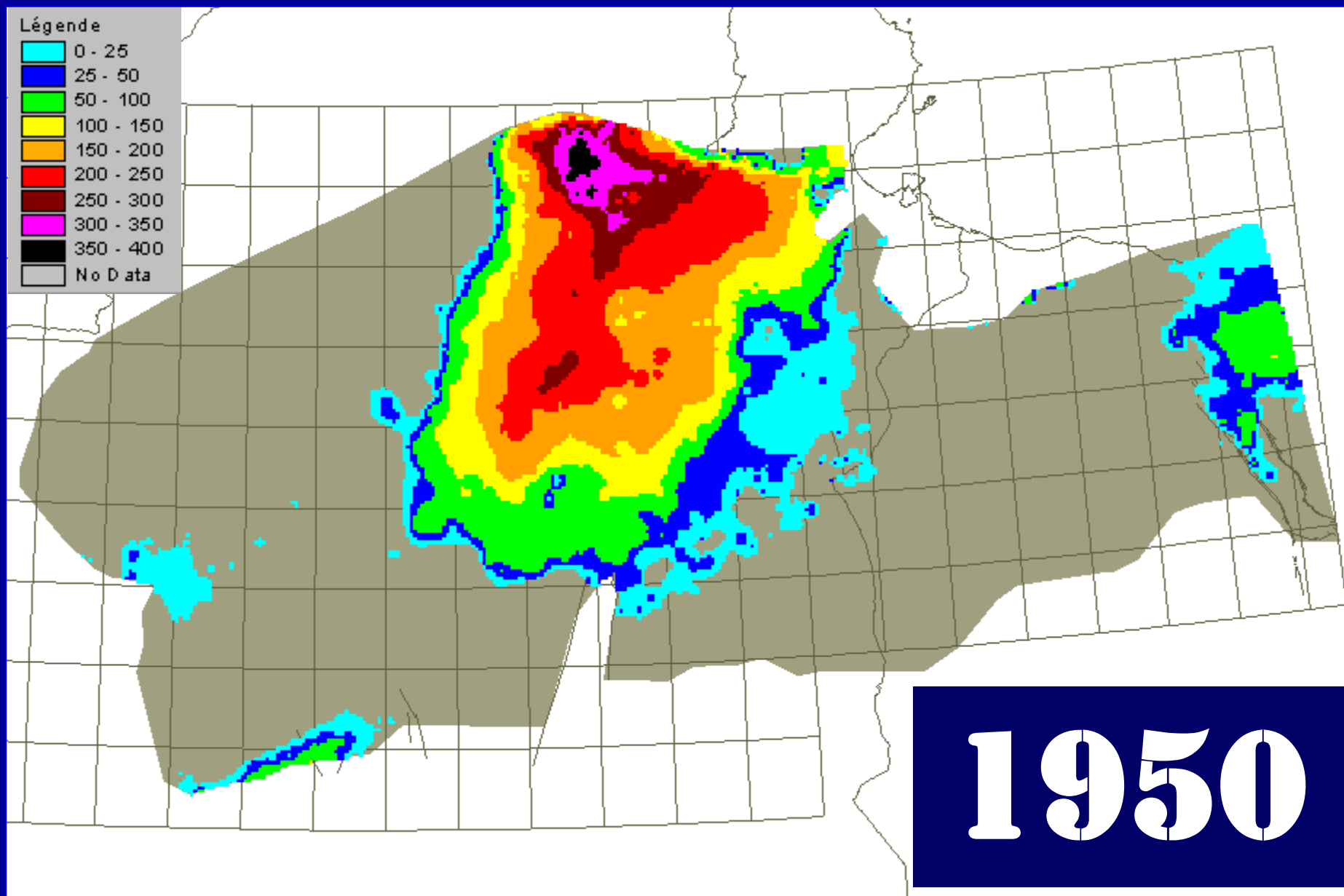
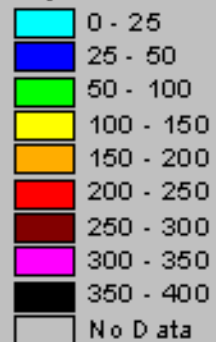
ARTESIANISM

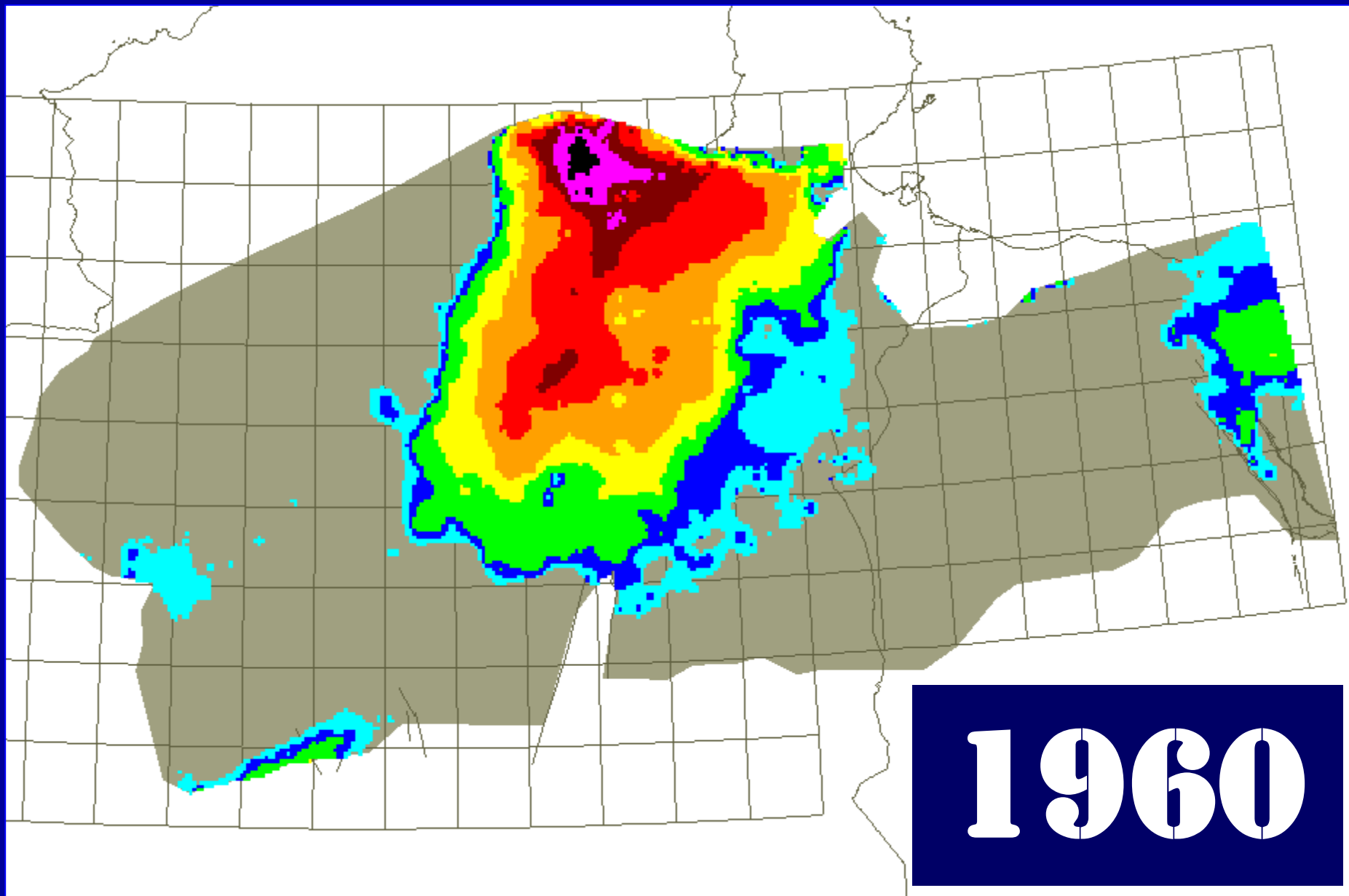
DRYING UP

1950 → 2050

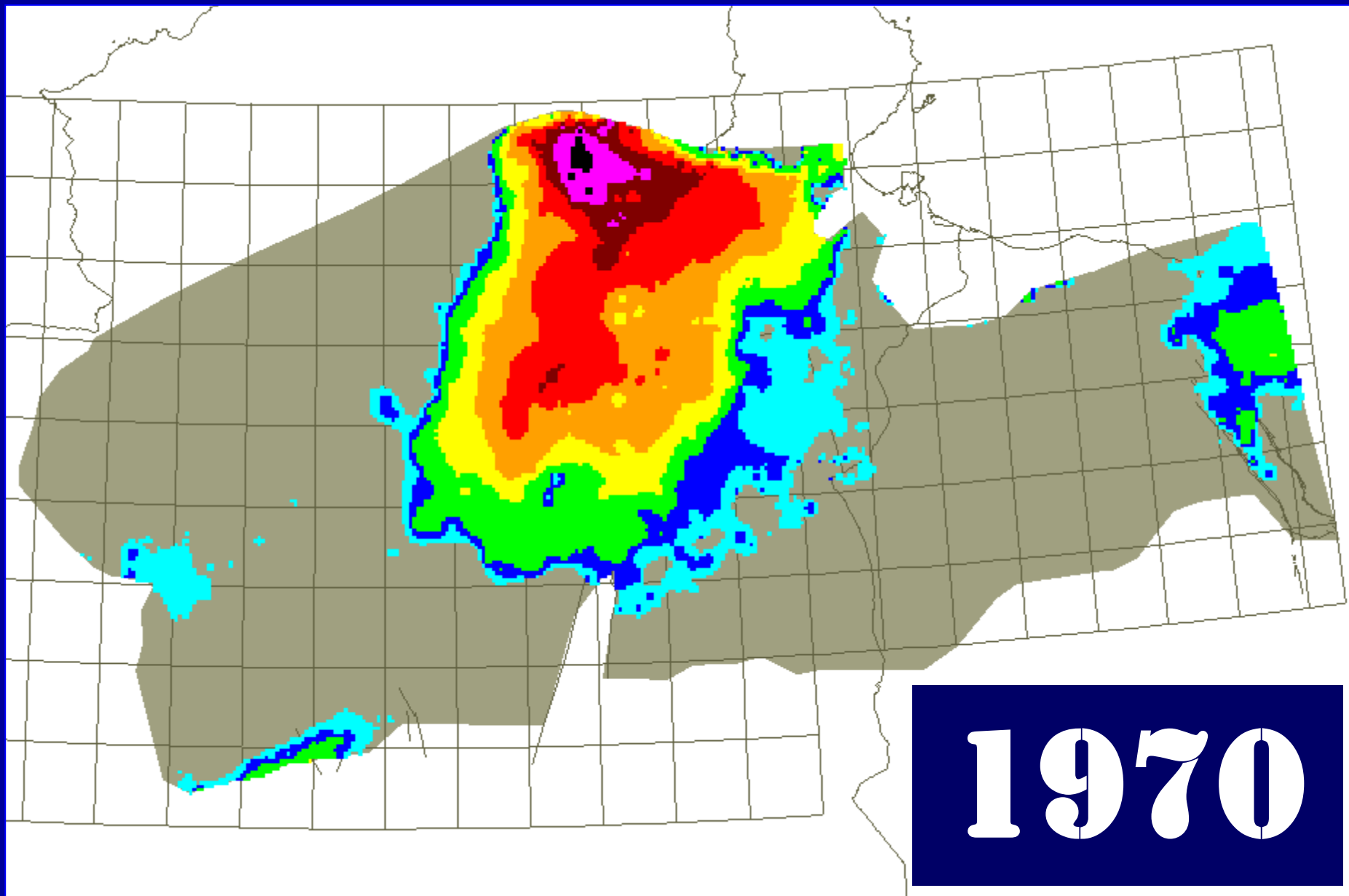
SCENARIO ZERO

Légende

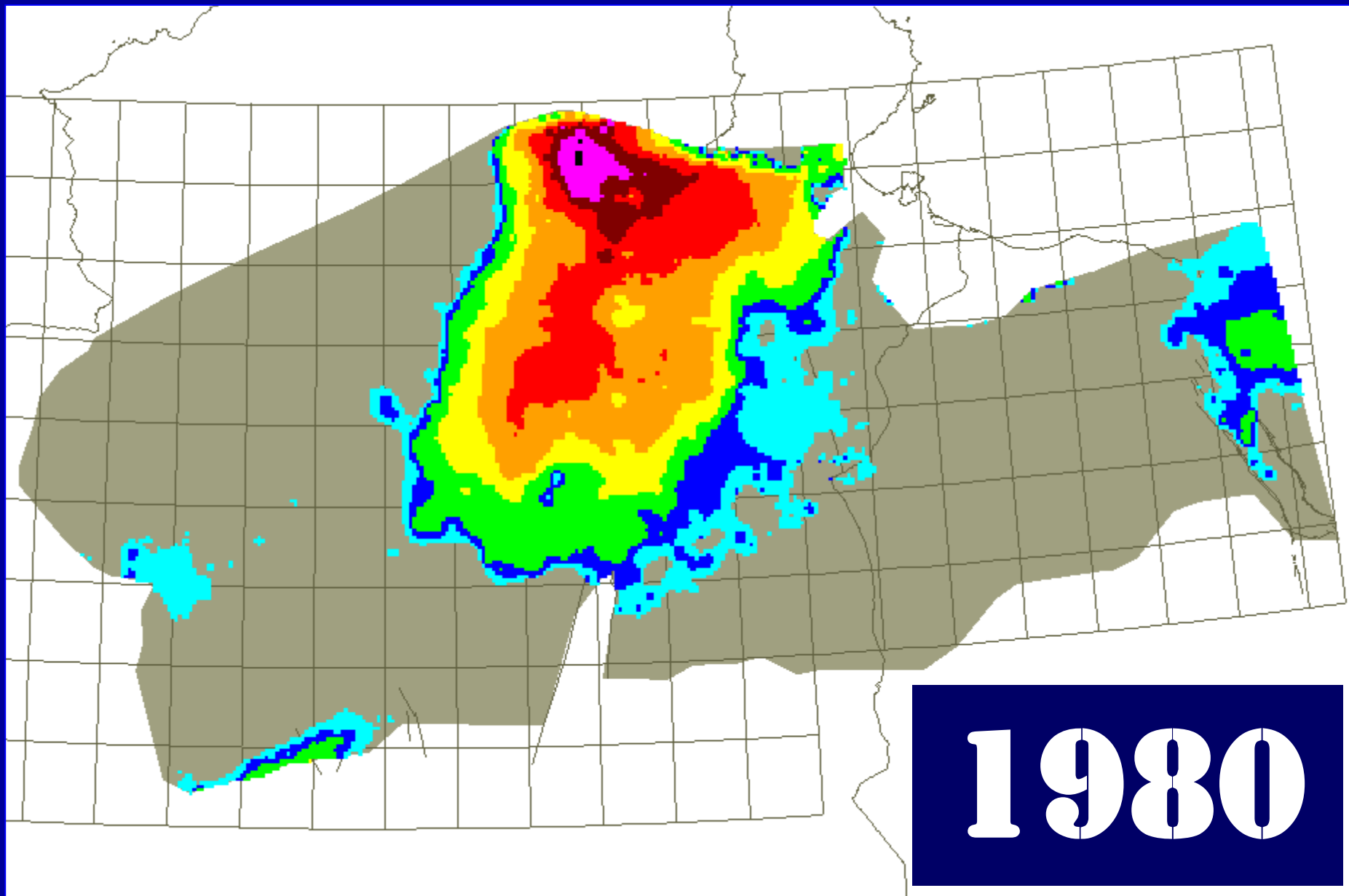




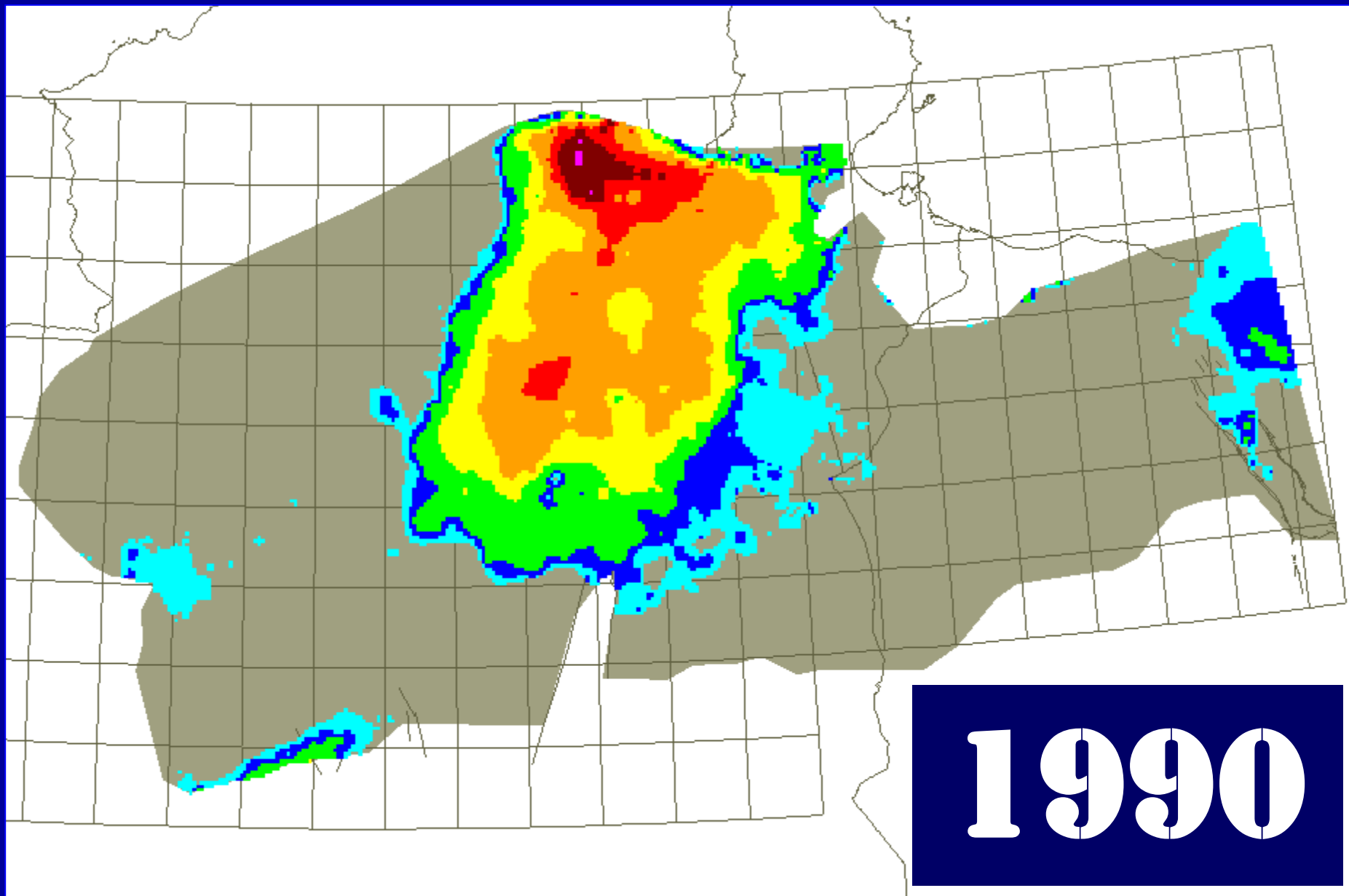
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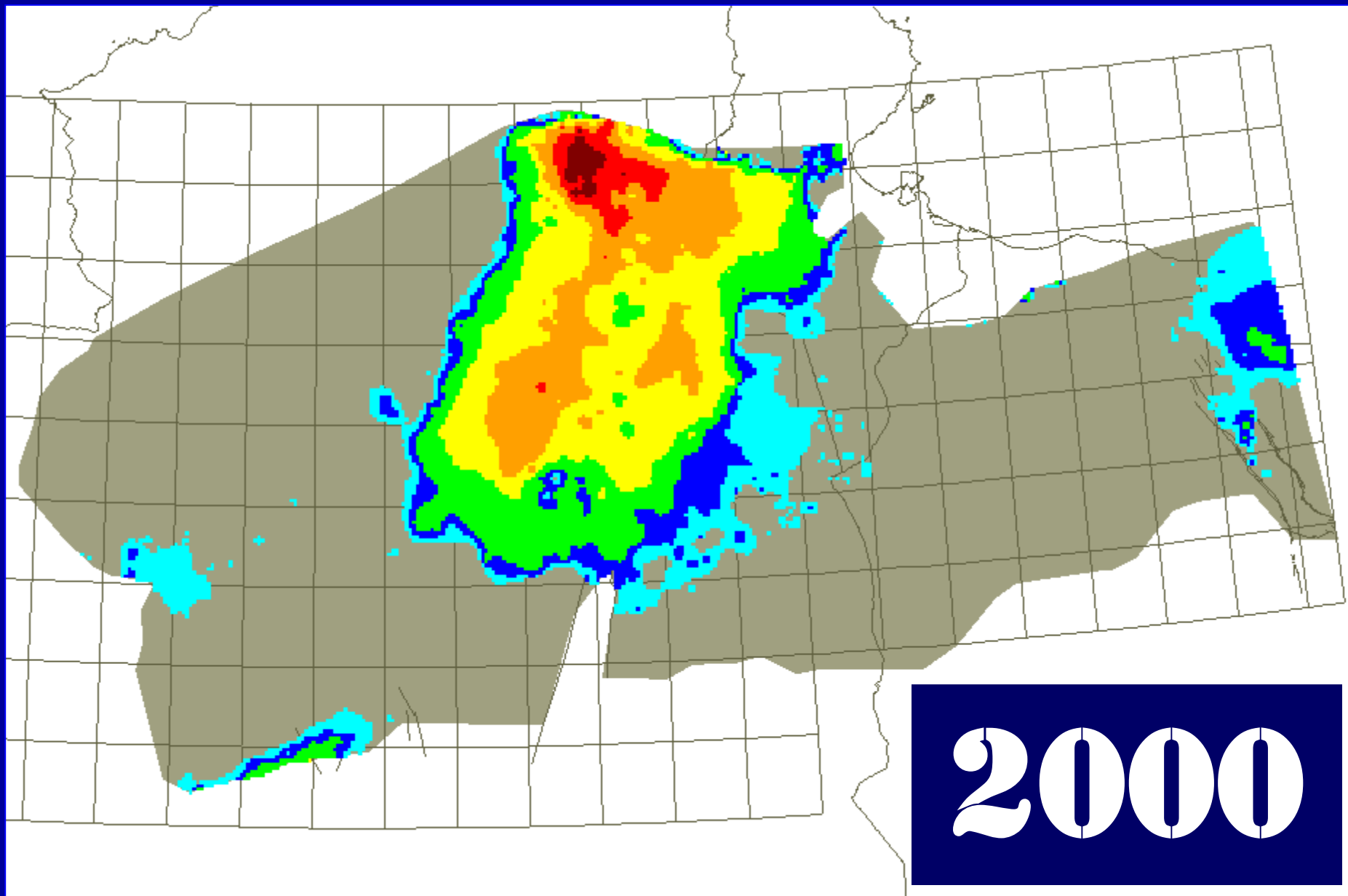


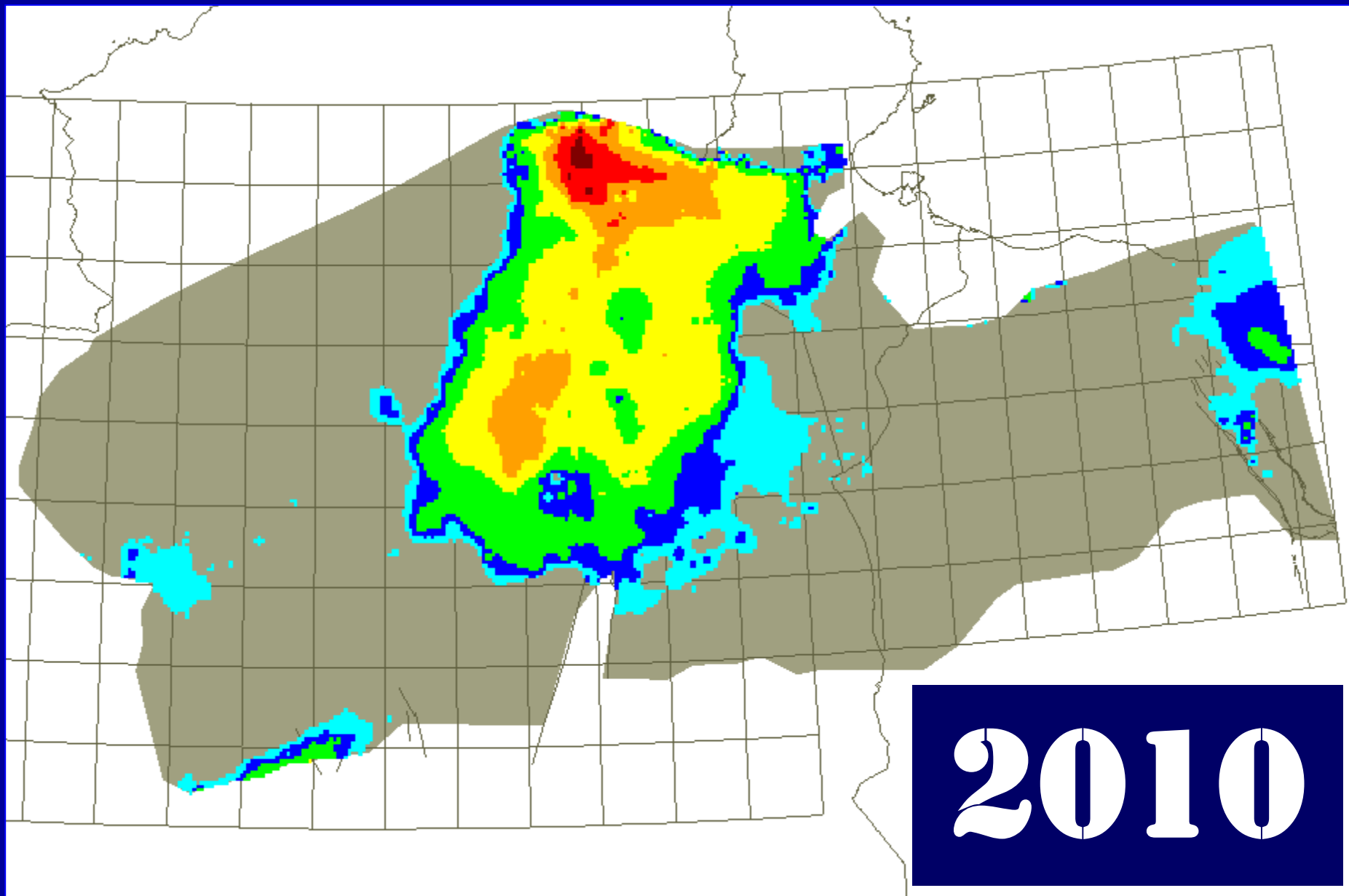
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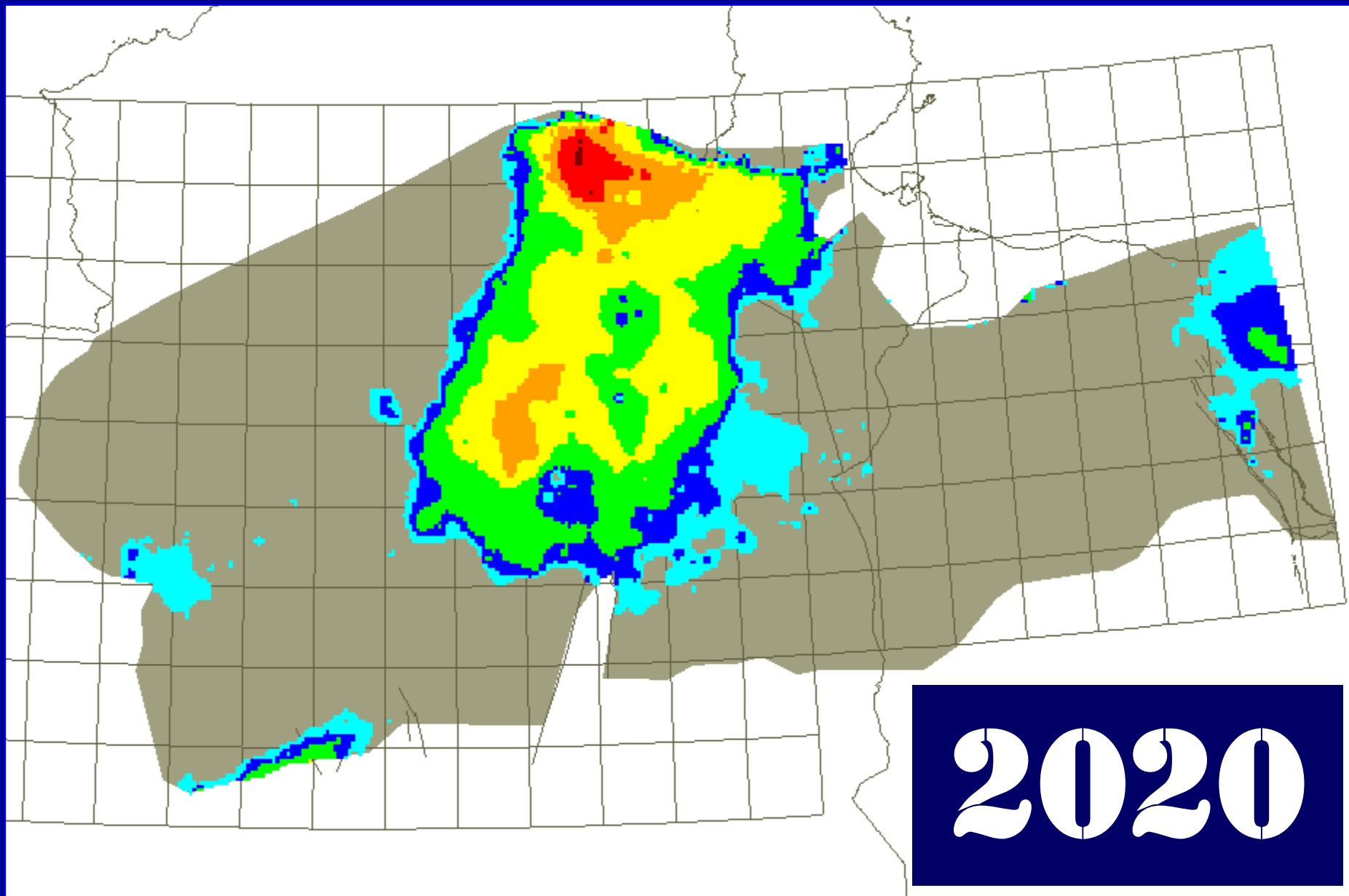
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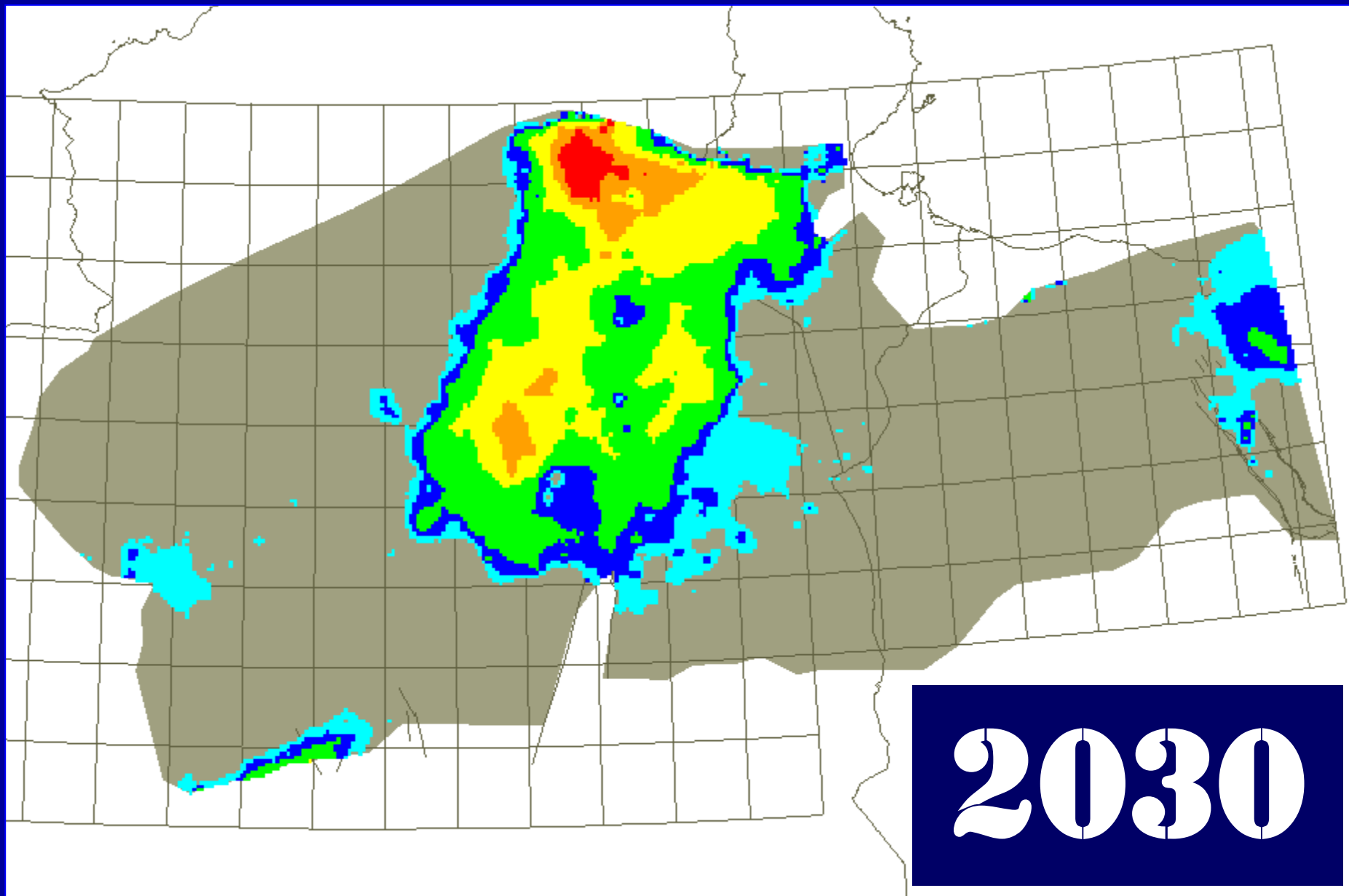




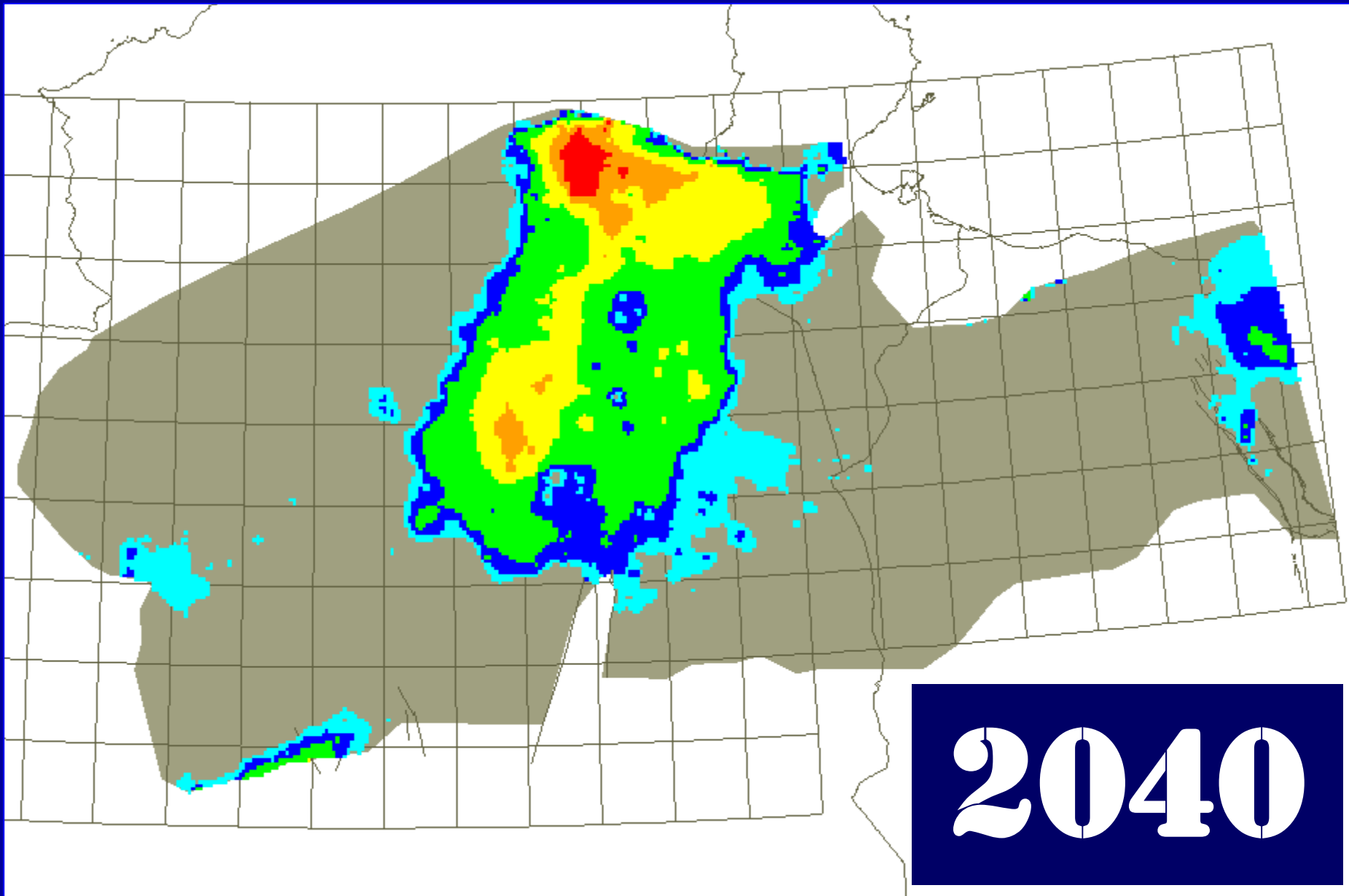
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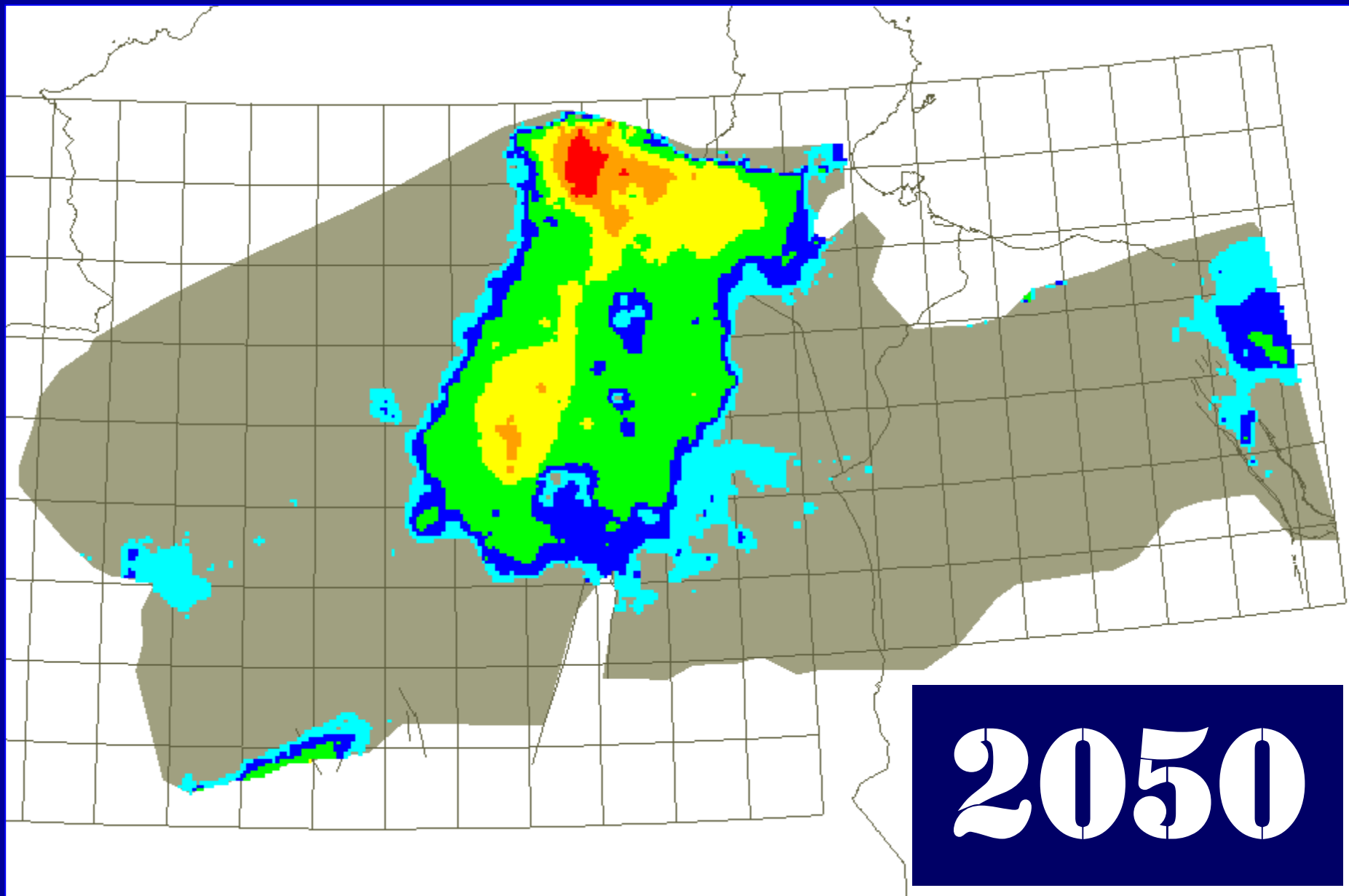


2020



2030





2050

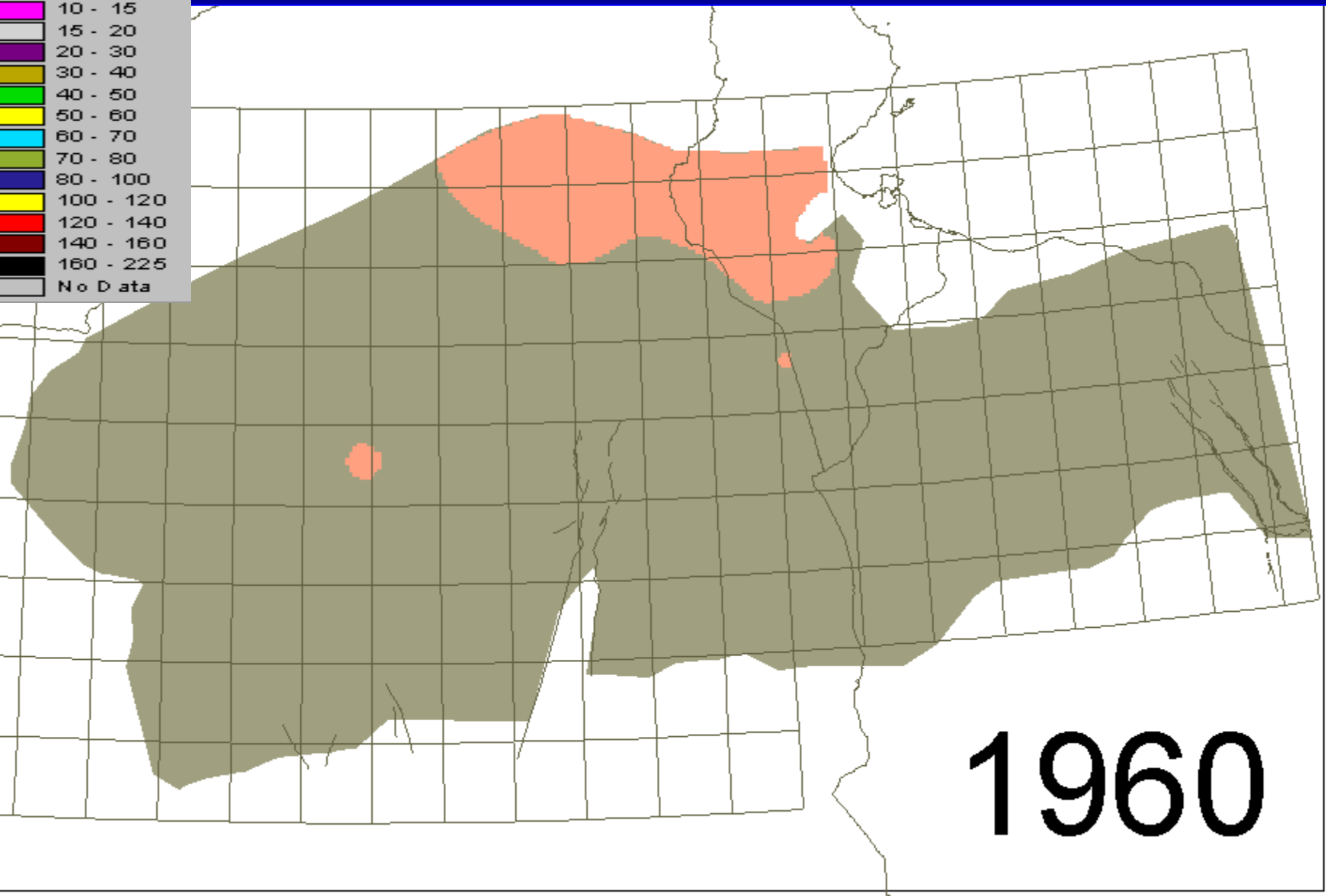
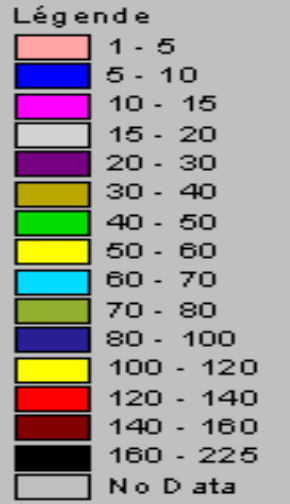
CONTINENTAL INTERCALAIRE

DROWDOWNS

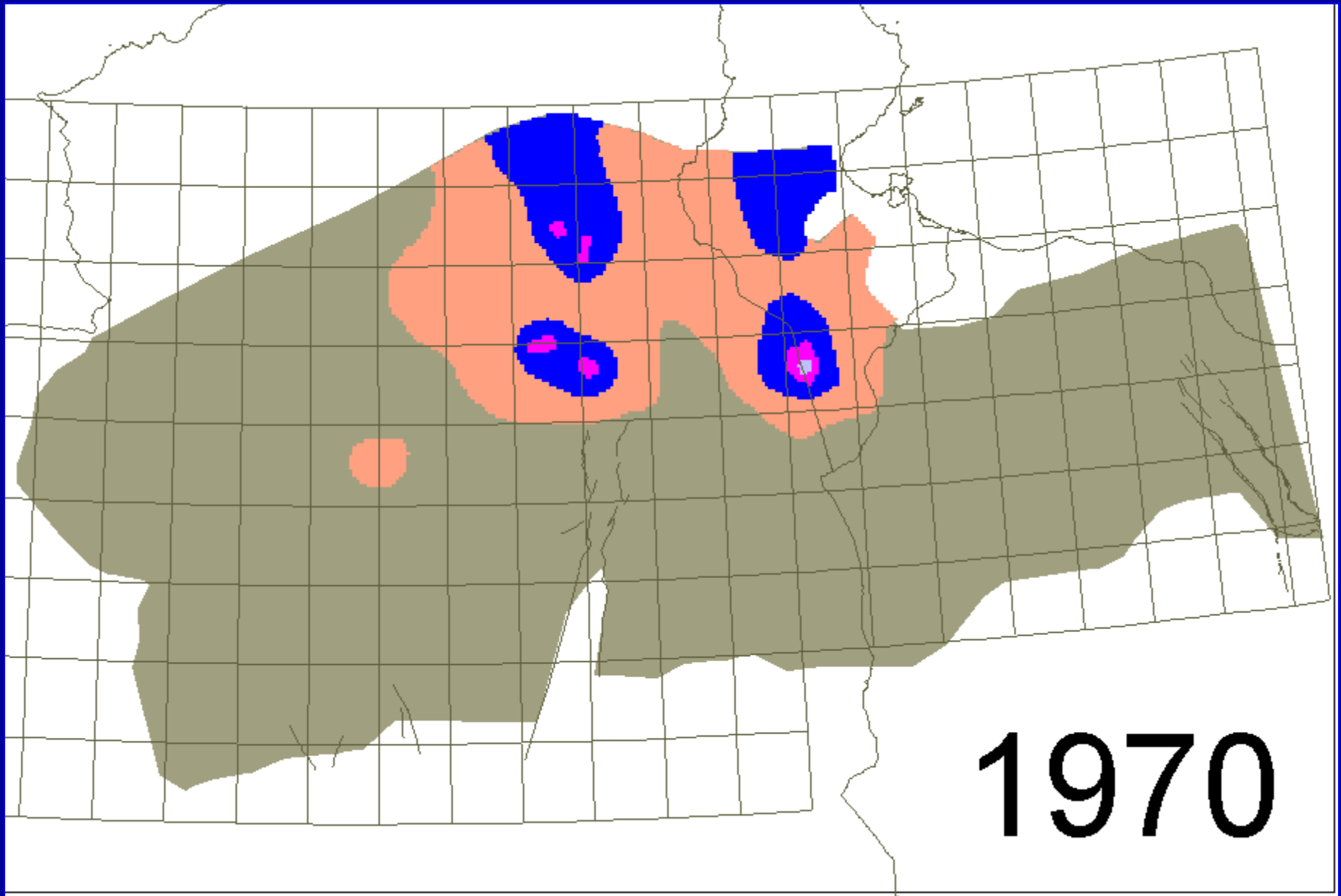
Water levels

1950 → 2050

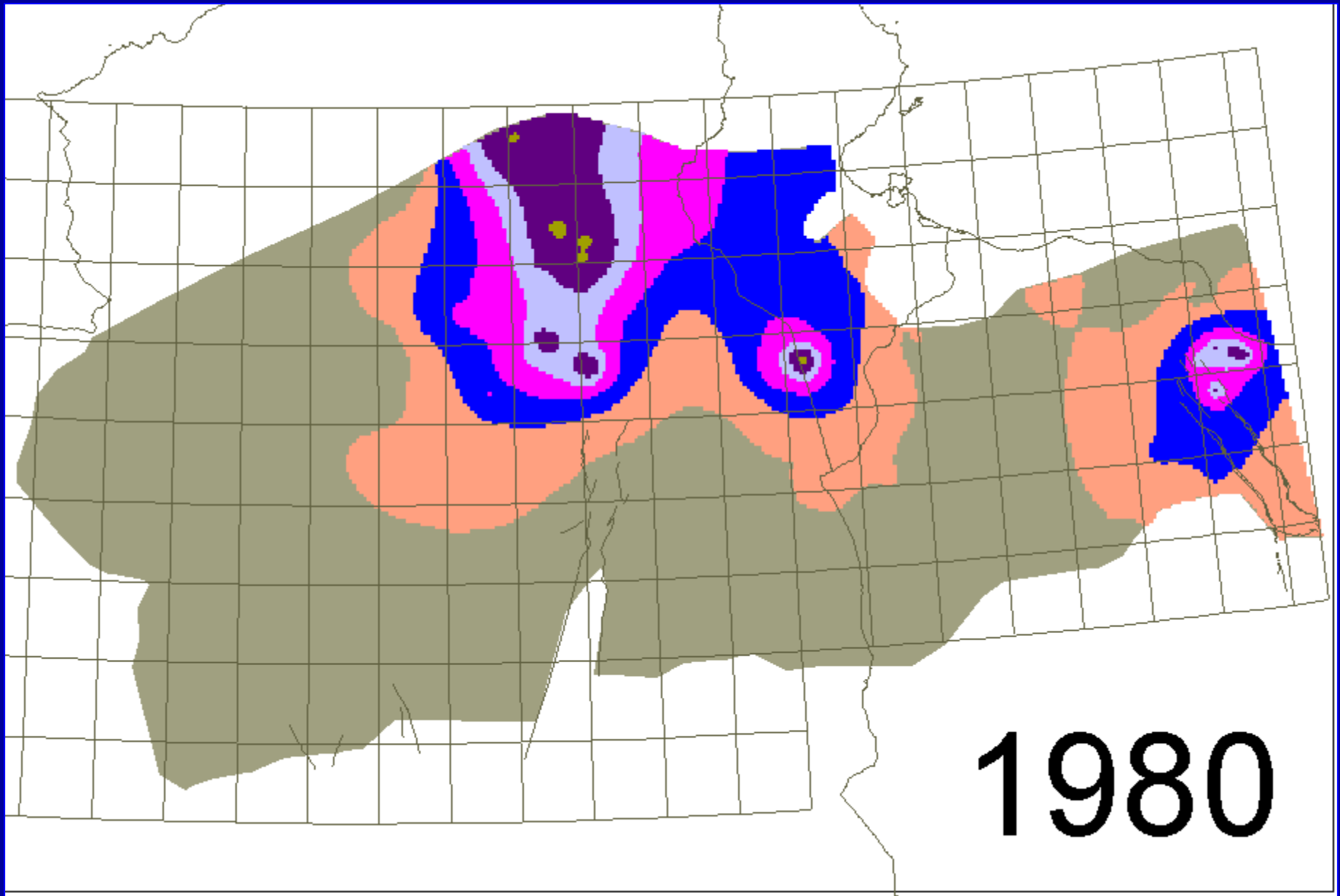
SCENARIO ZERO

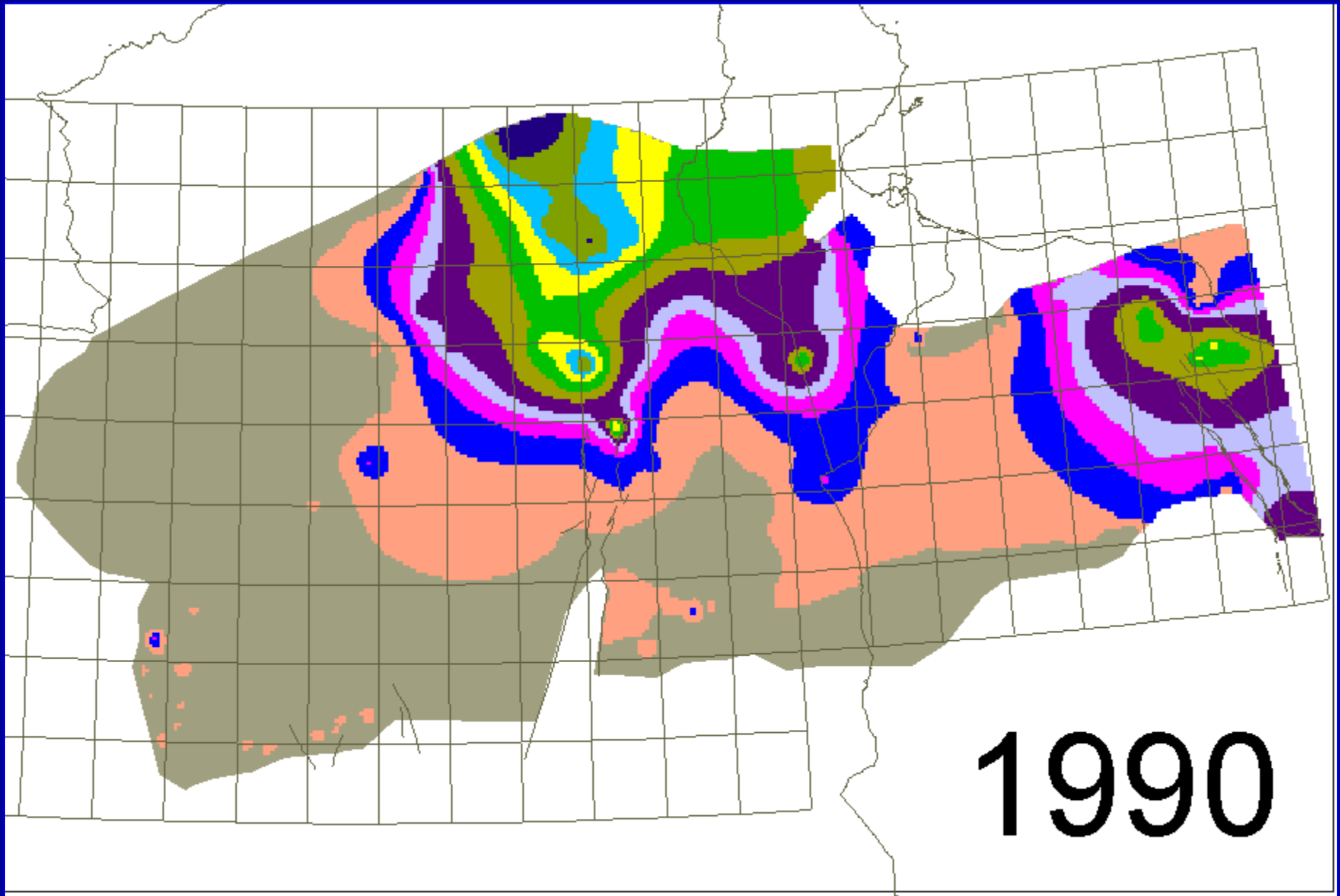


1960

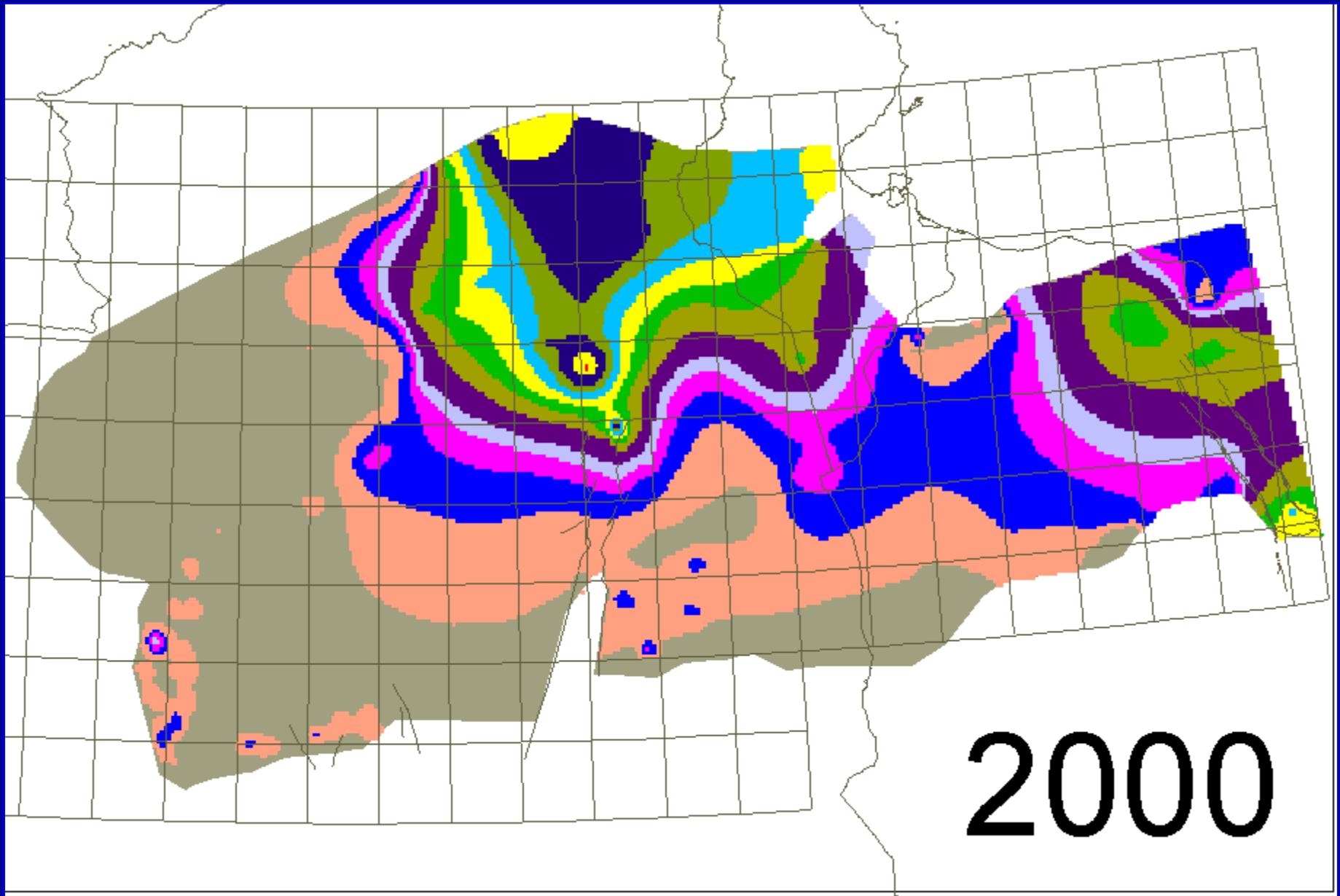


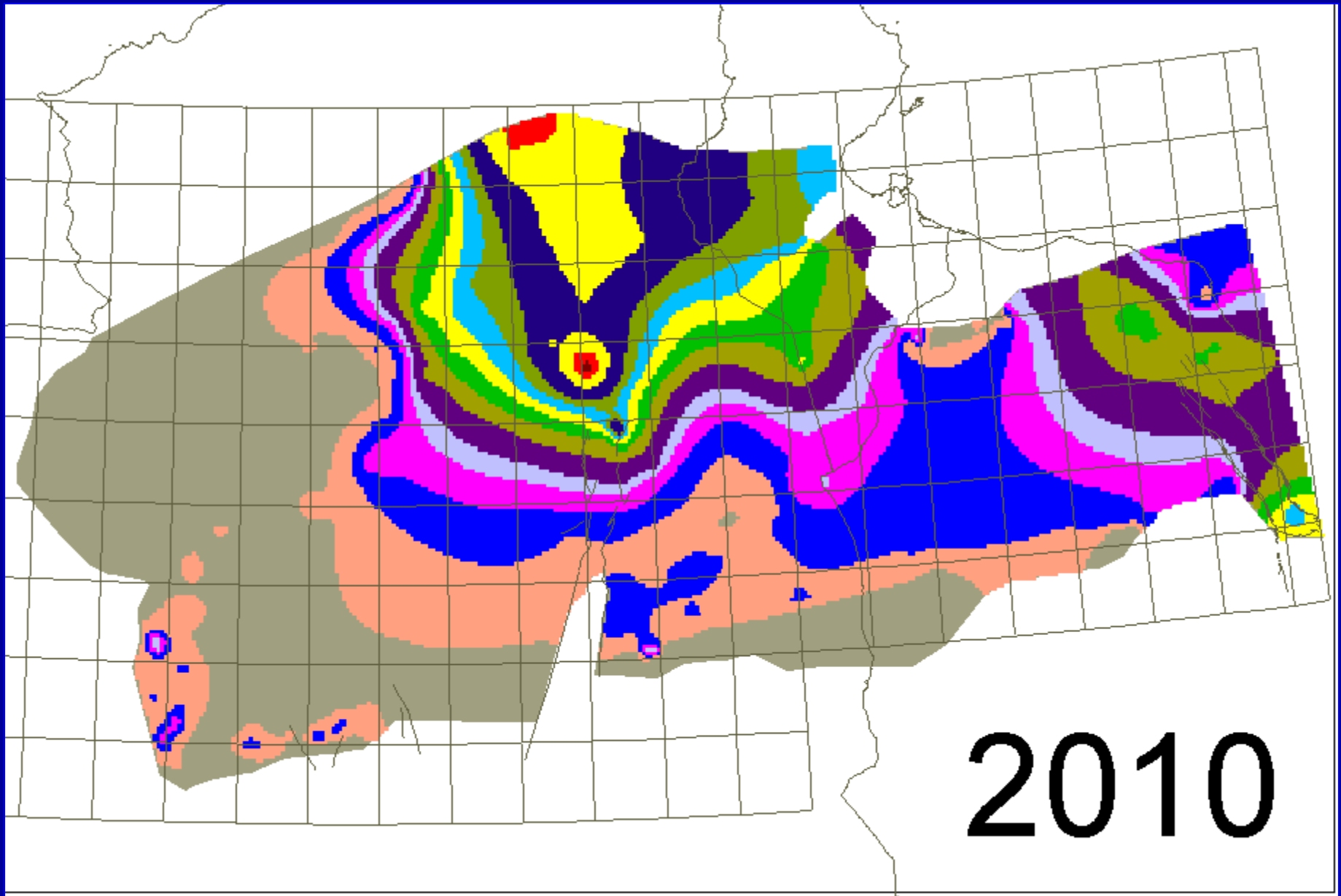
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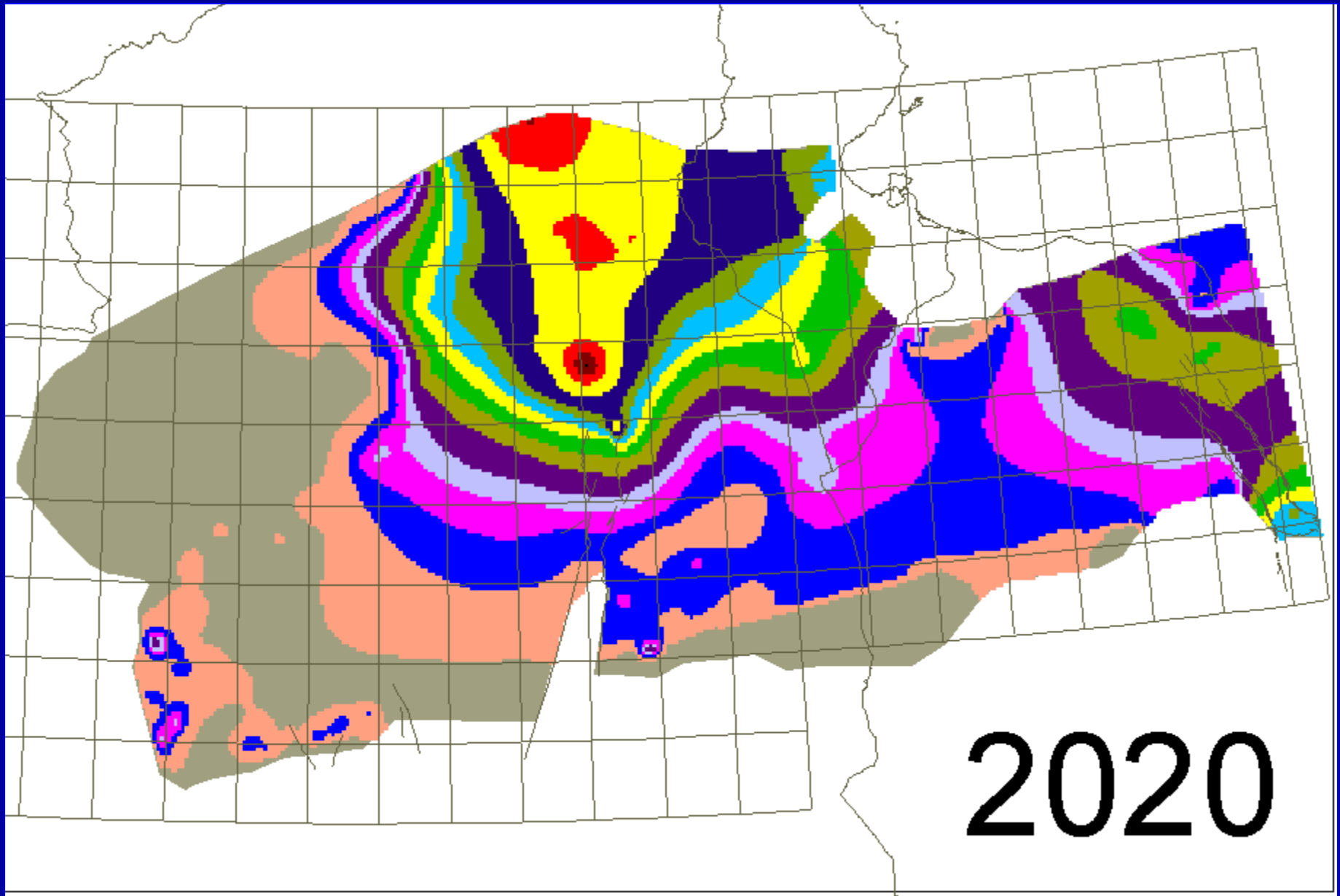




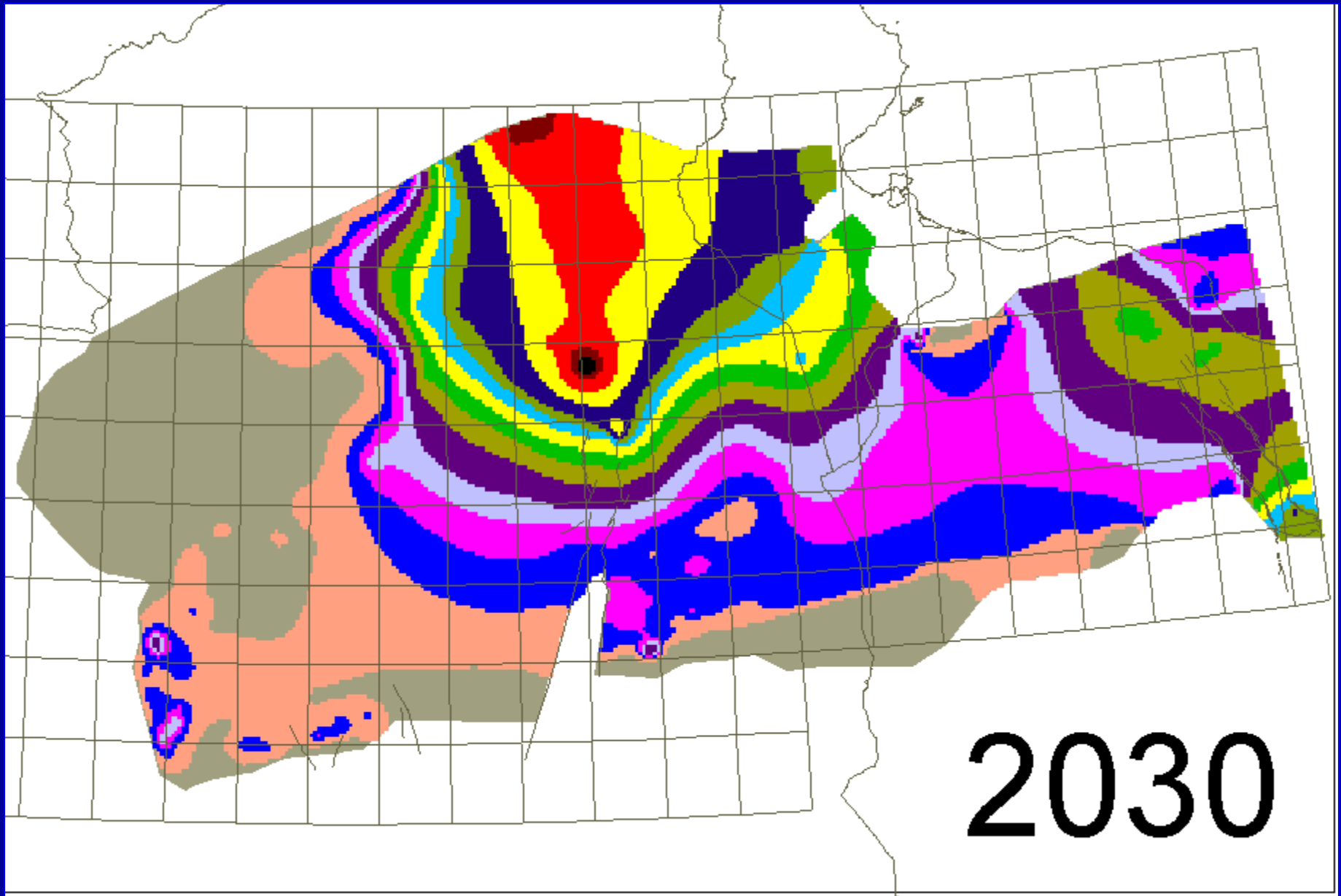
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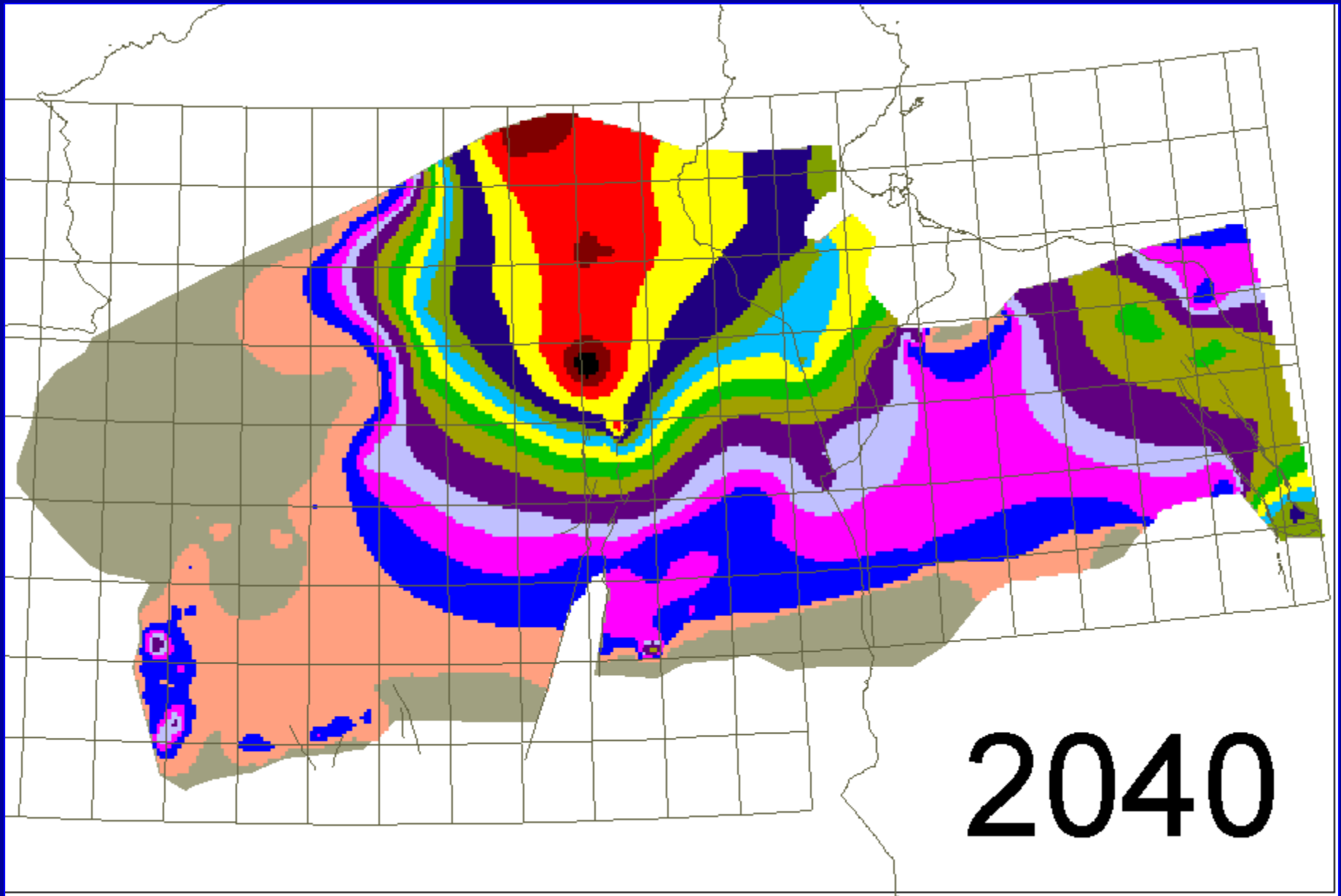


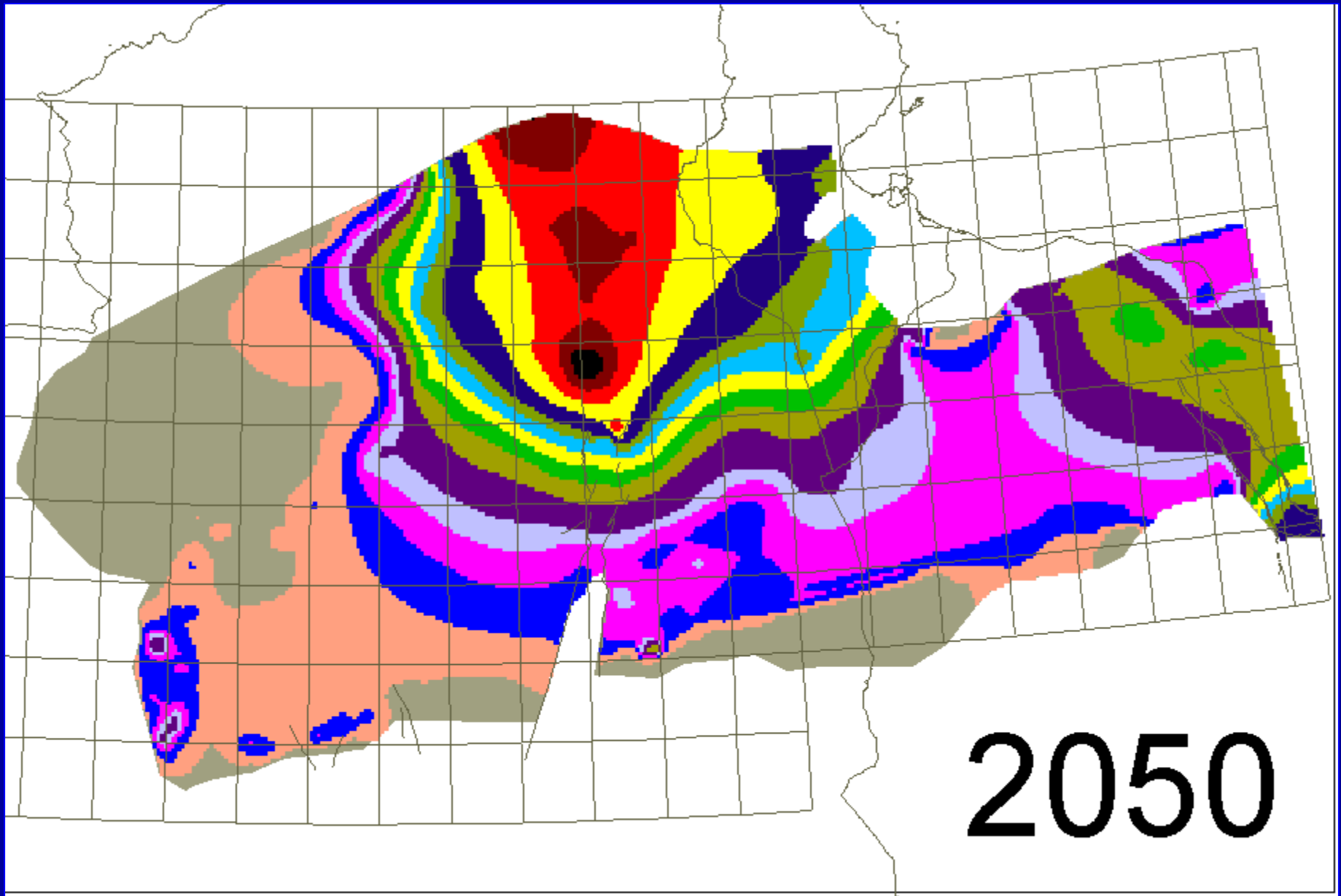




2020





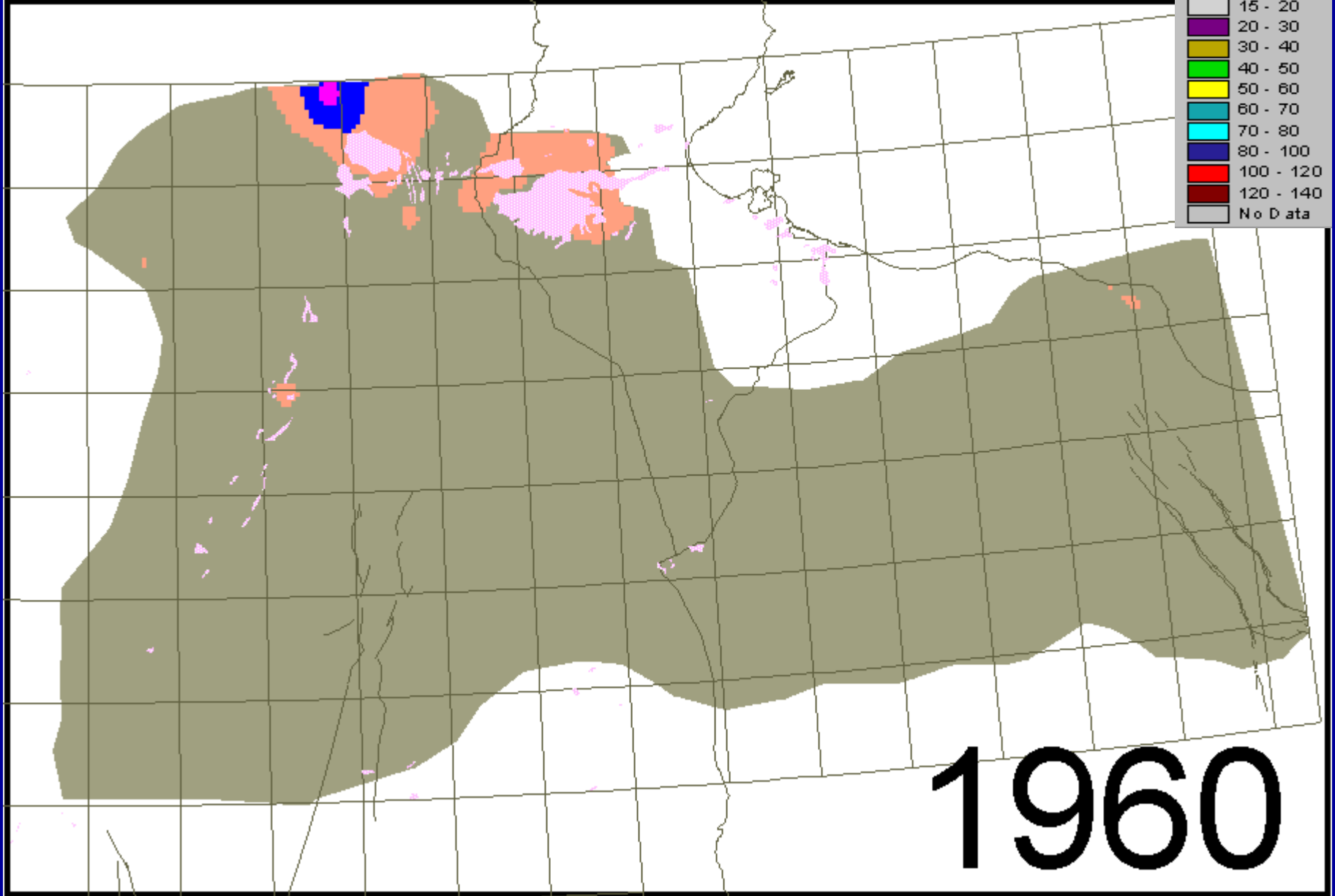
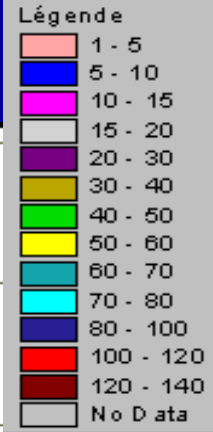


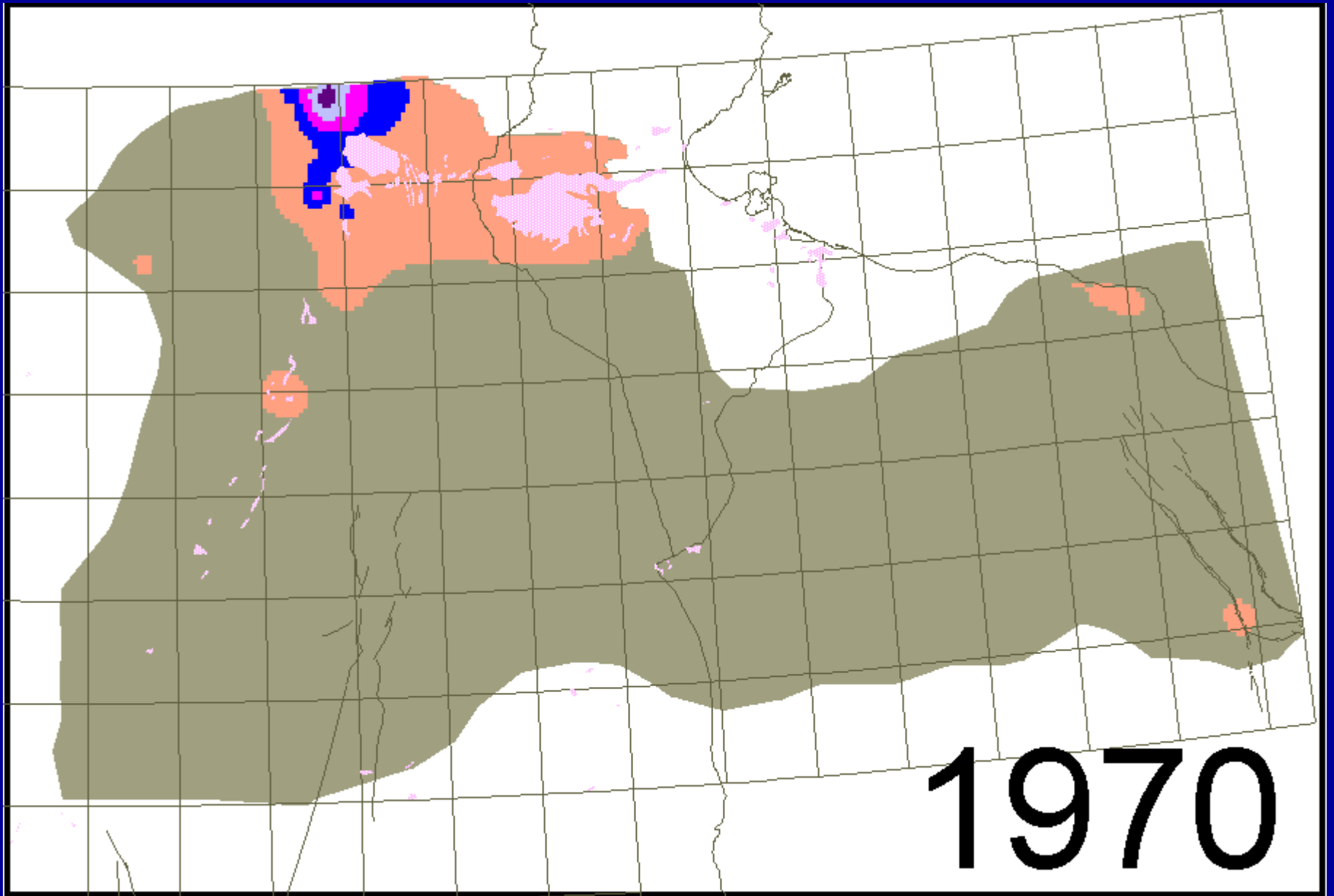
TERMINAL COMPLEXE

DROWDOWNS

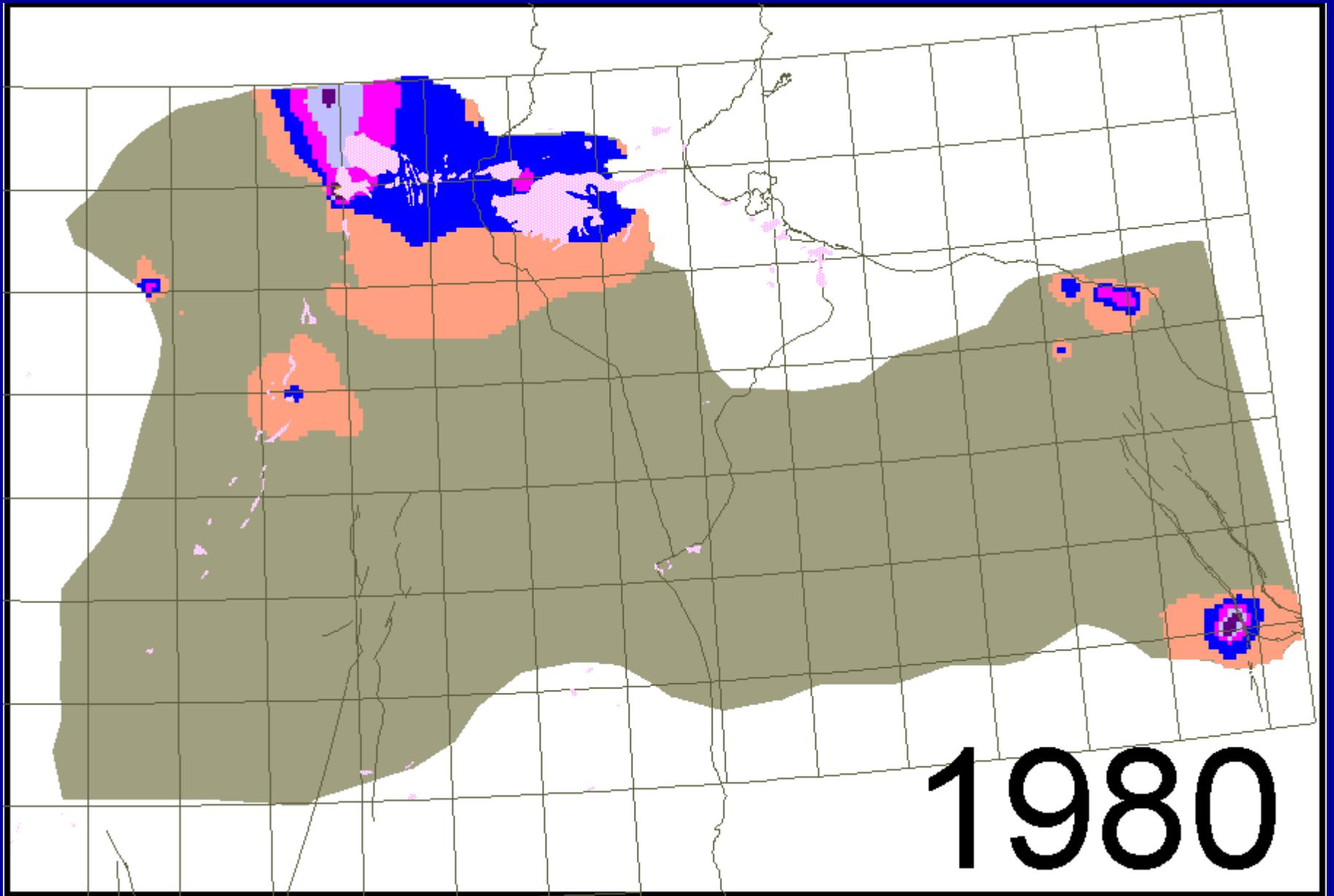
1950 → 2050

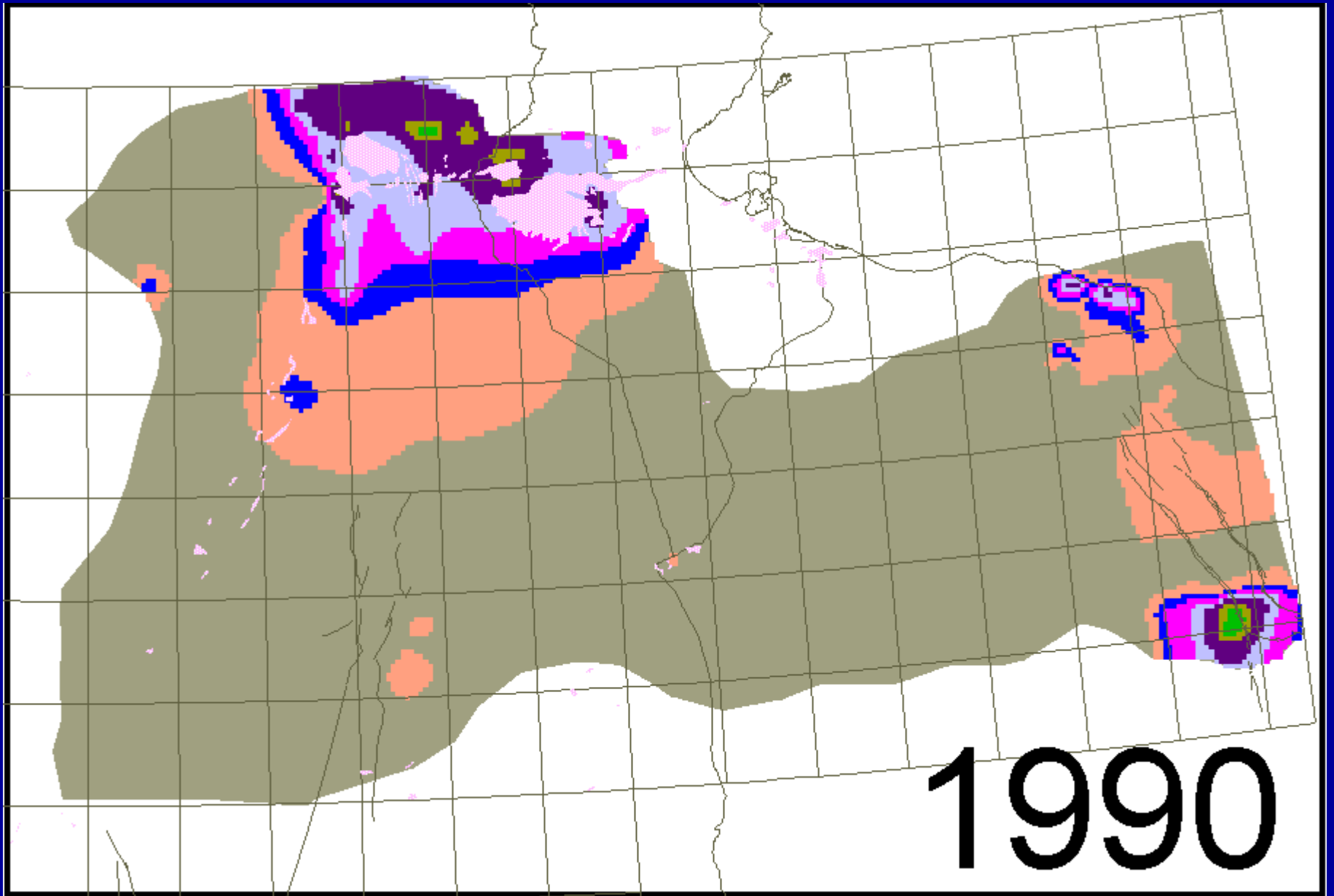
SCENARIO ZERO



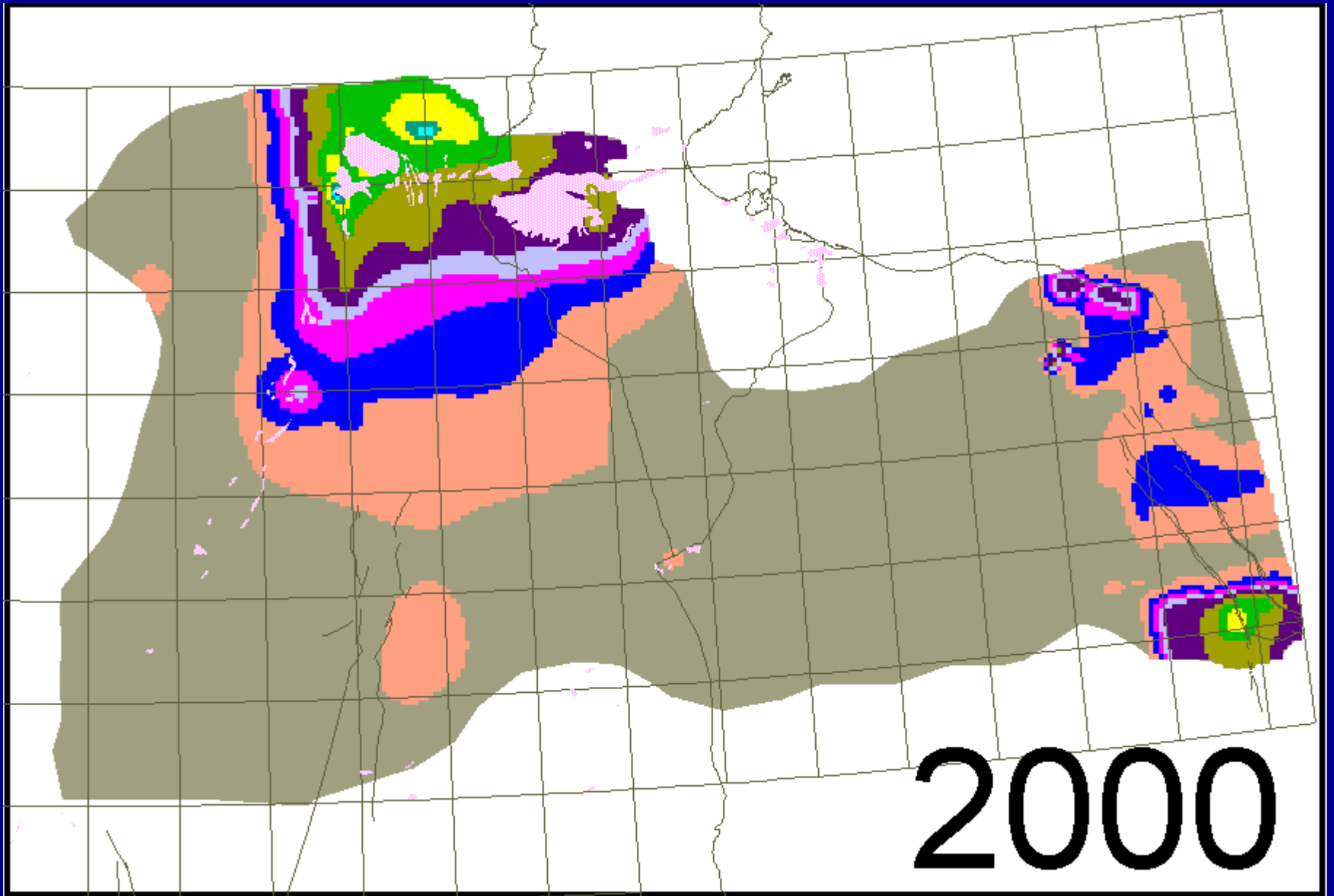


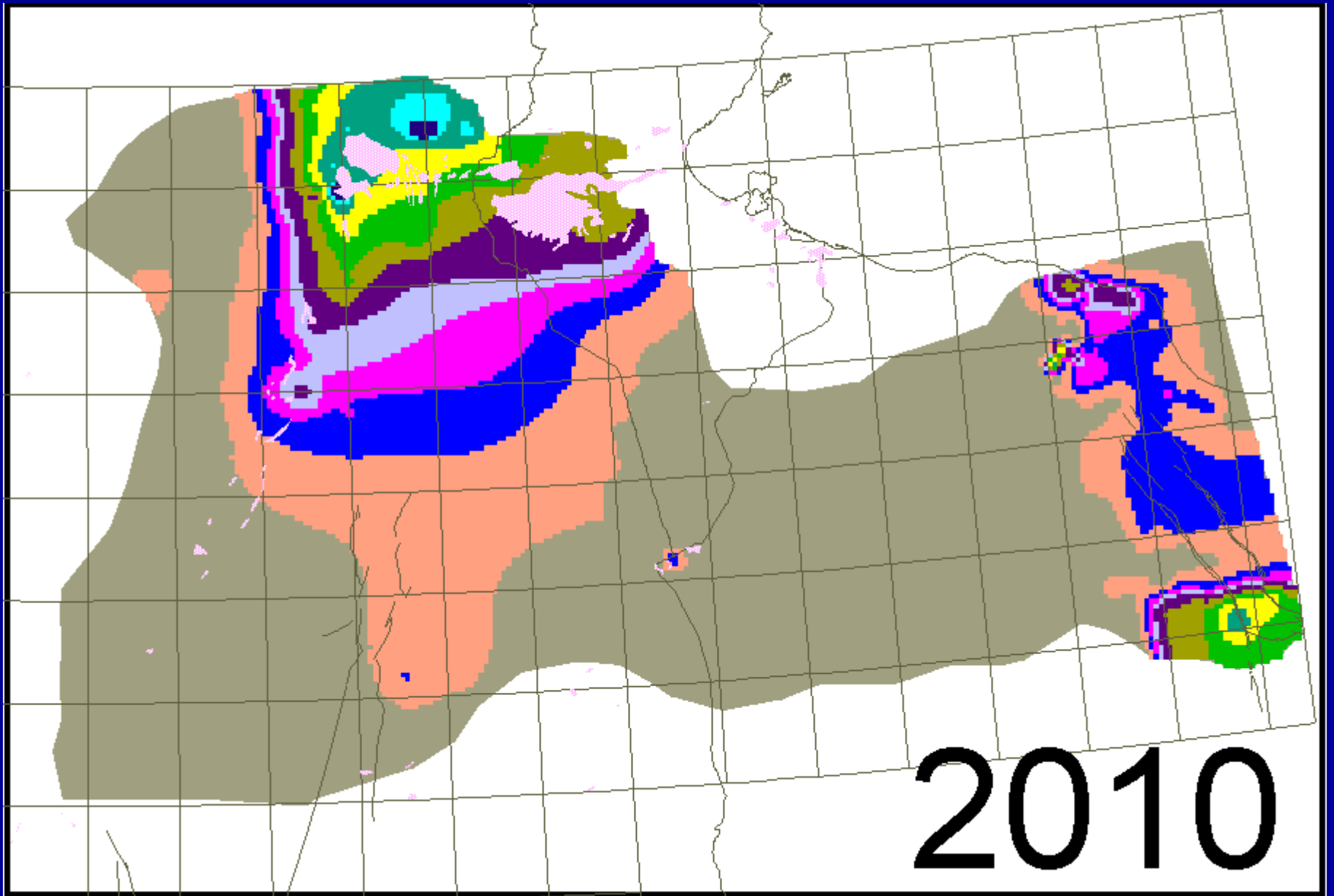
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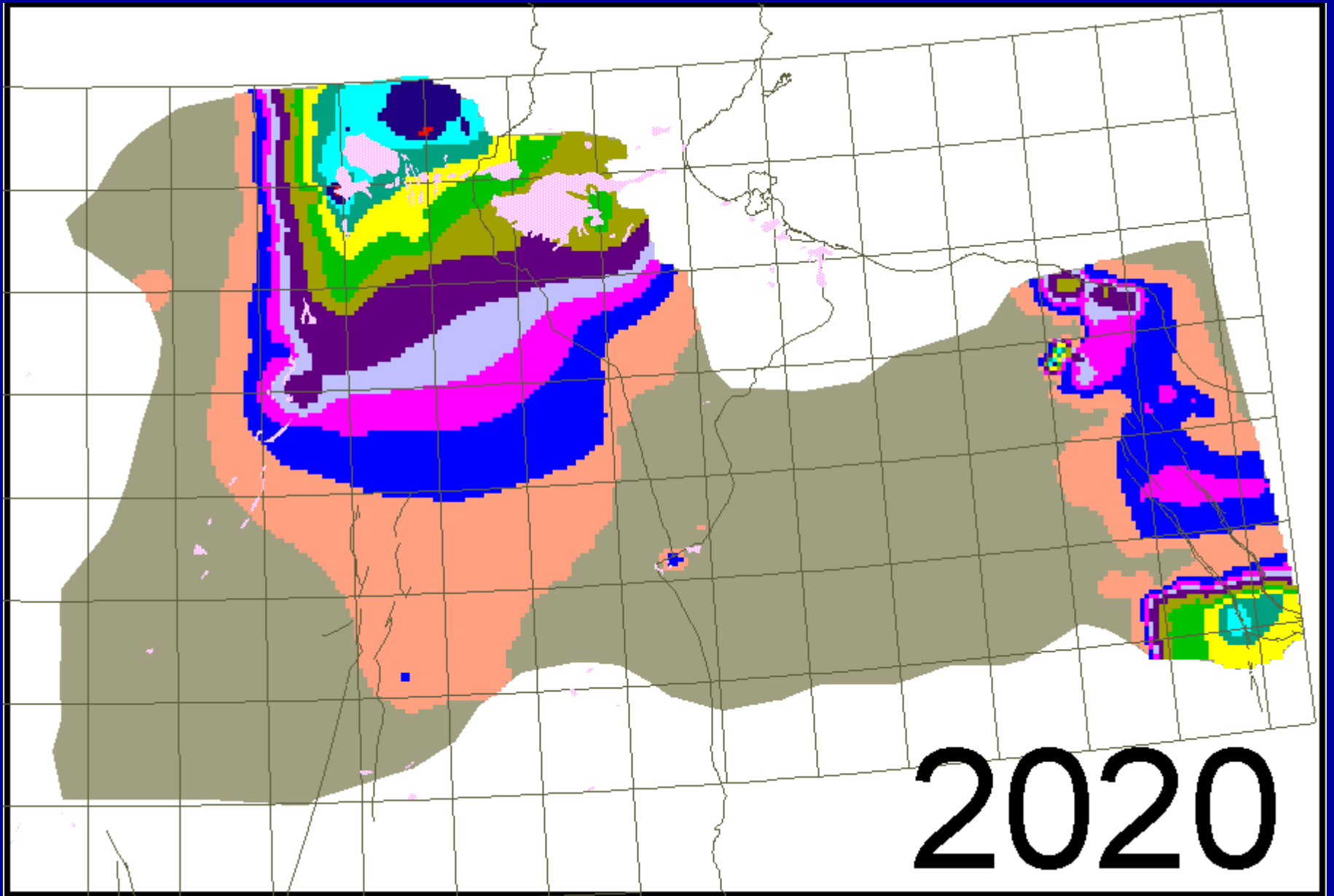


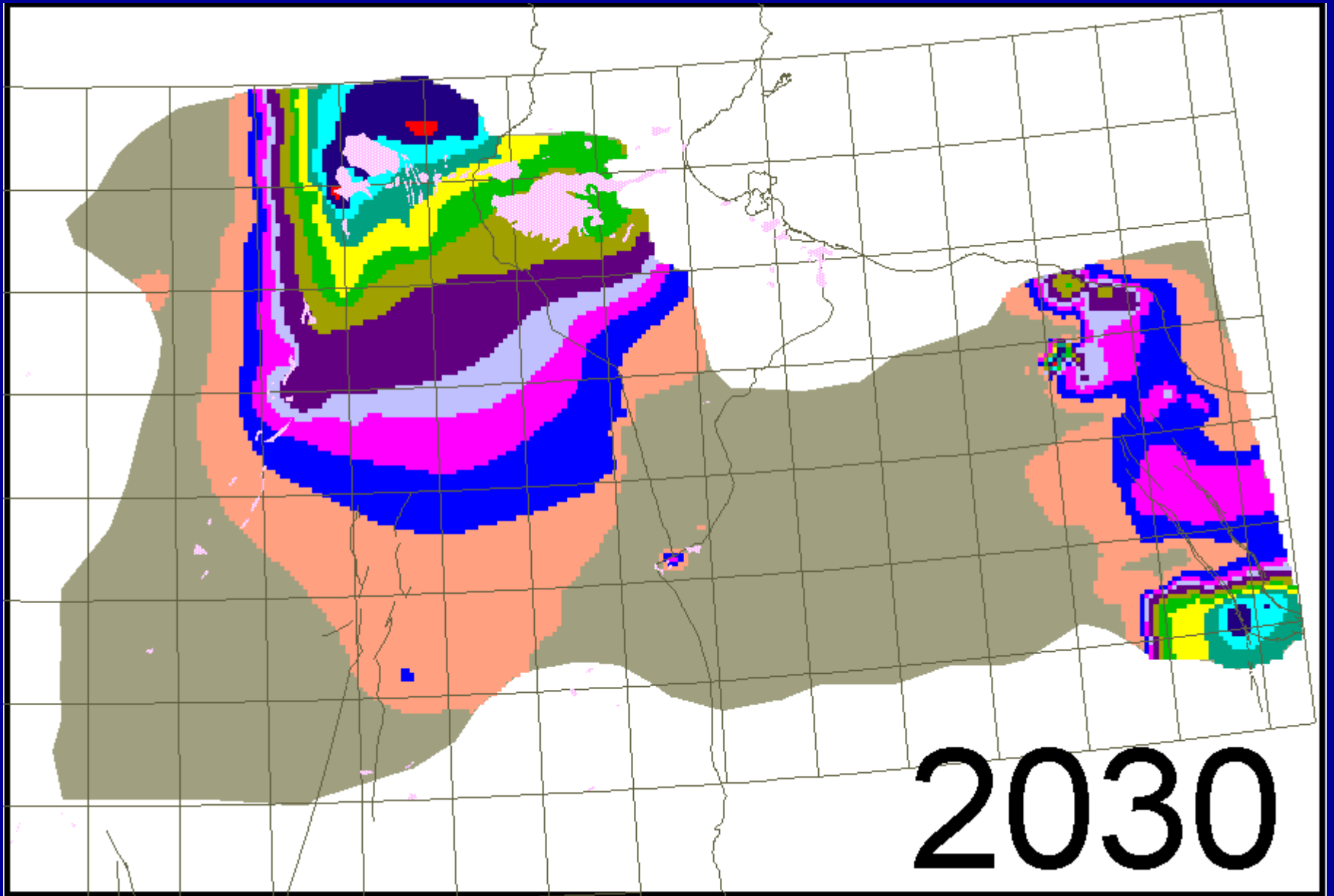


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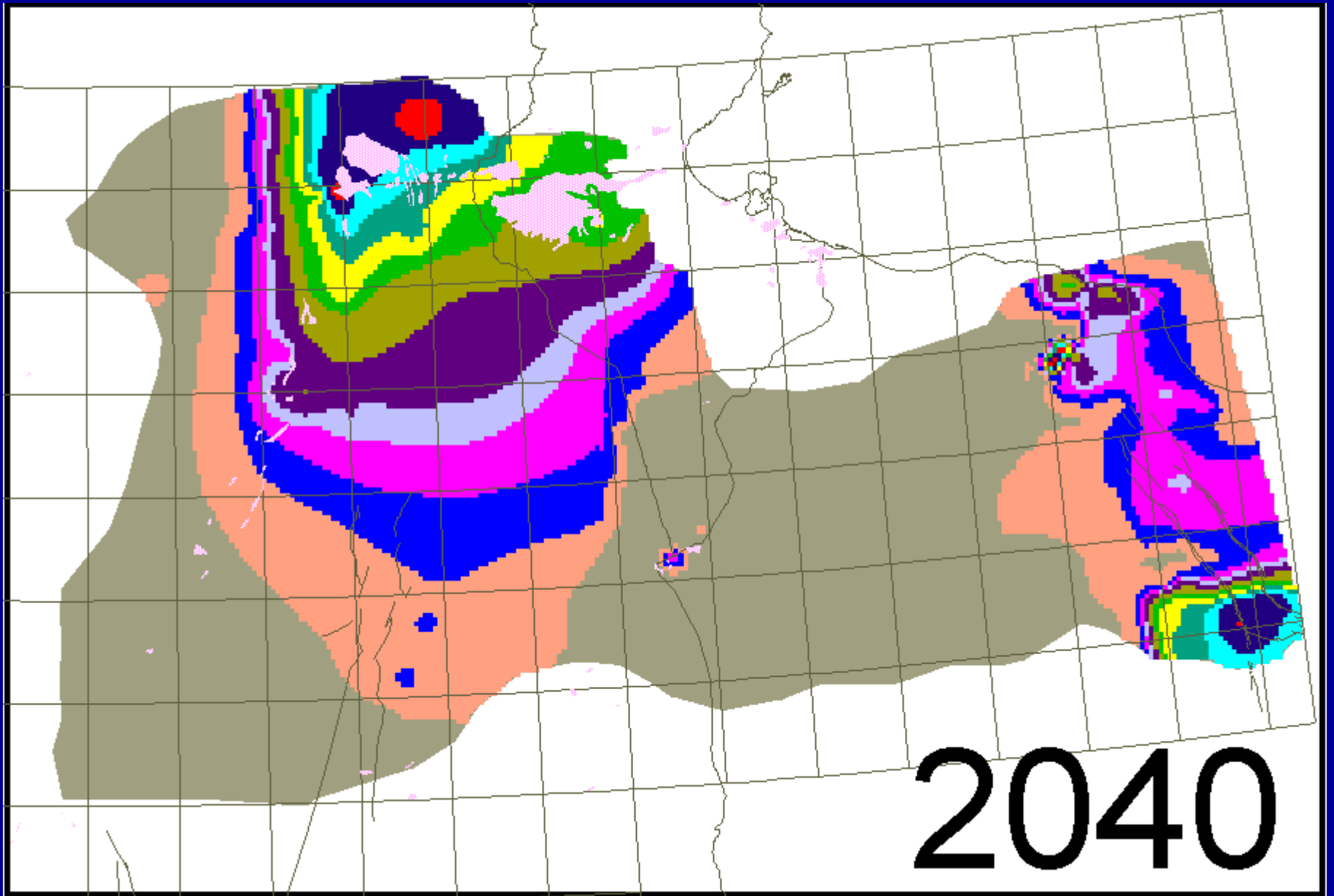




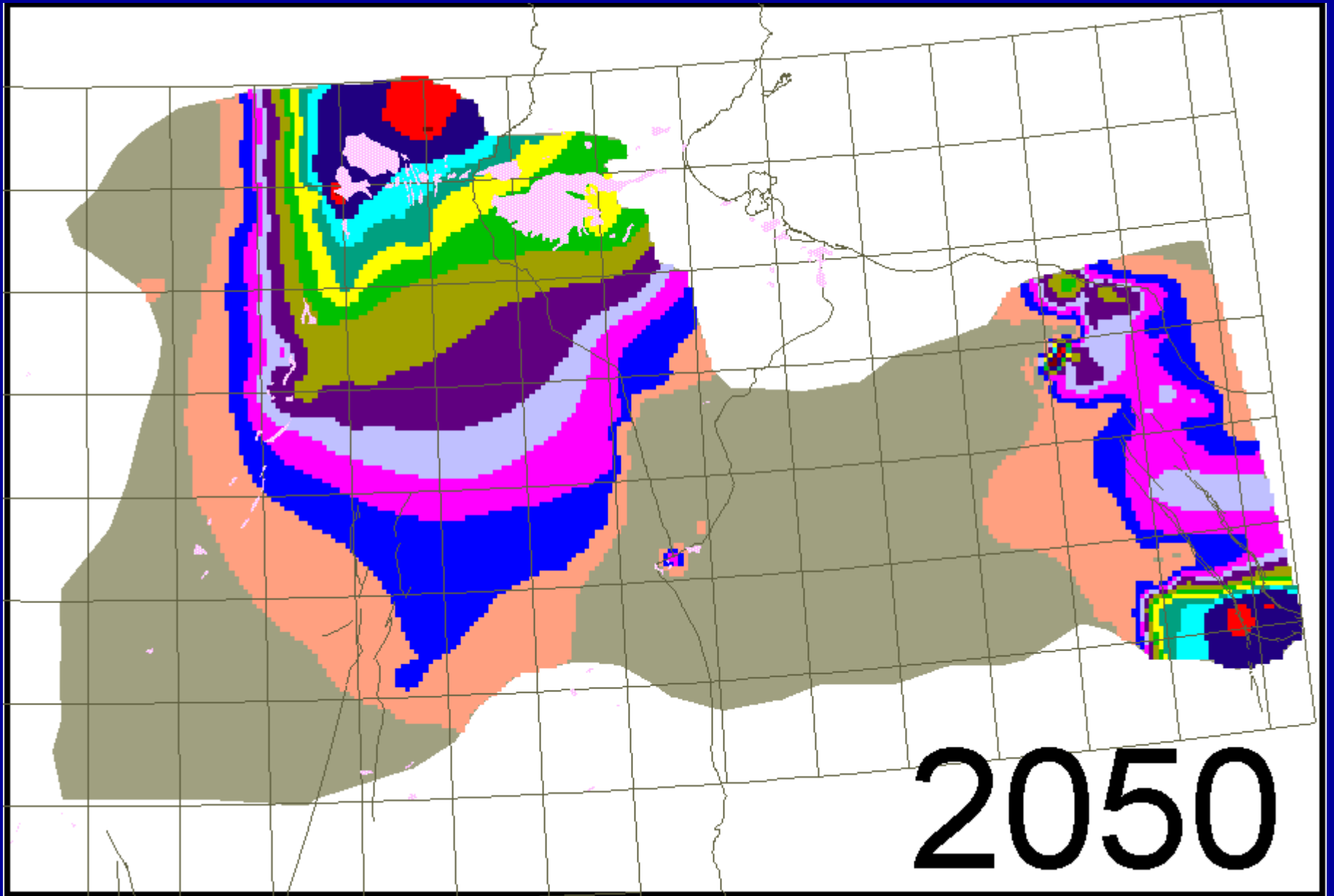


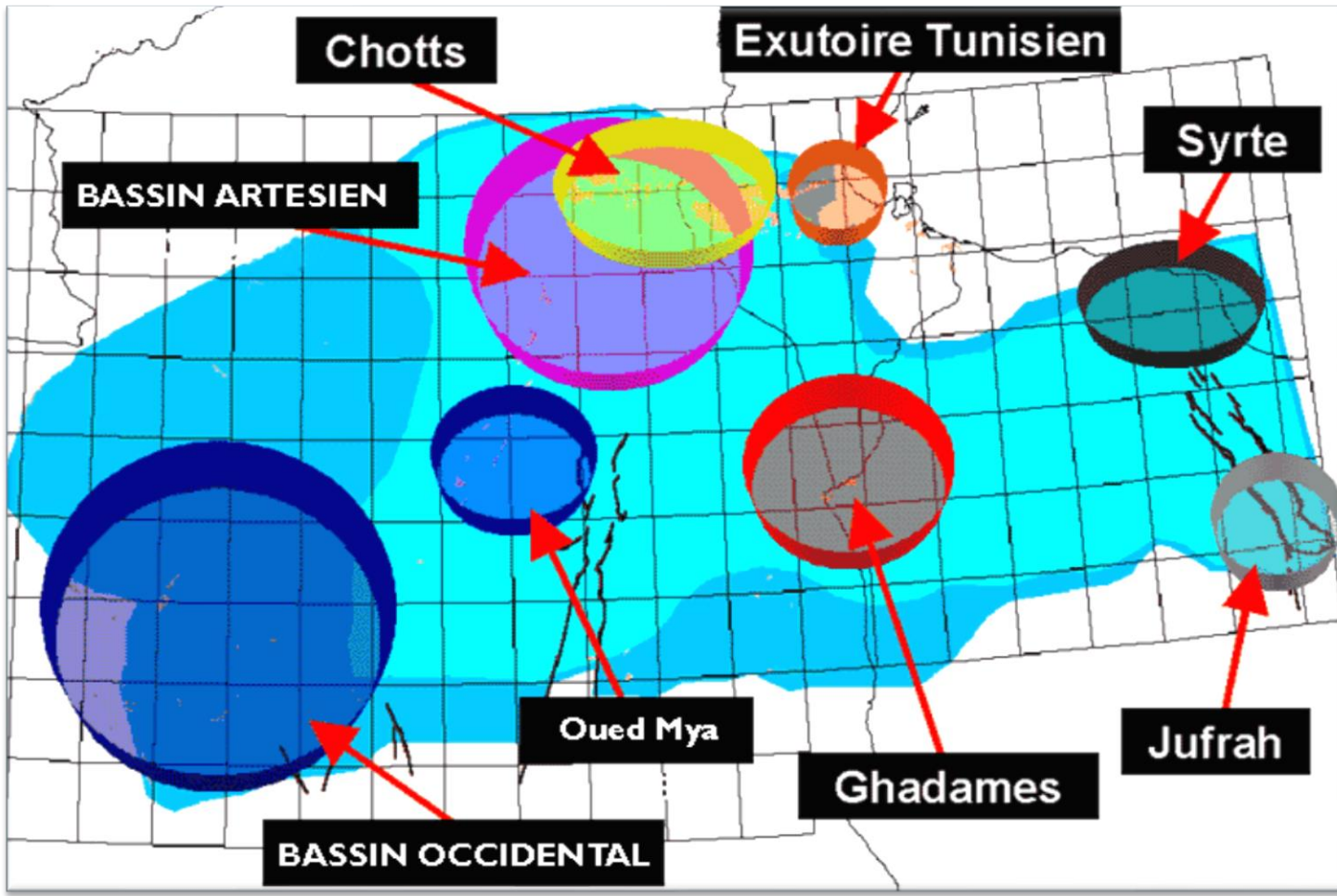


2030

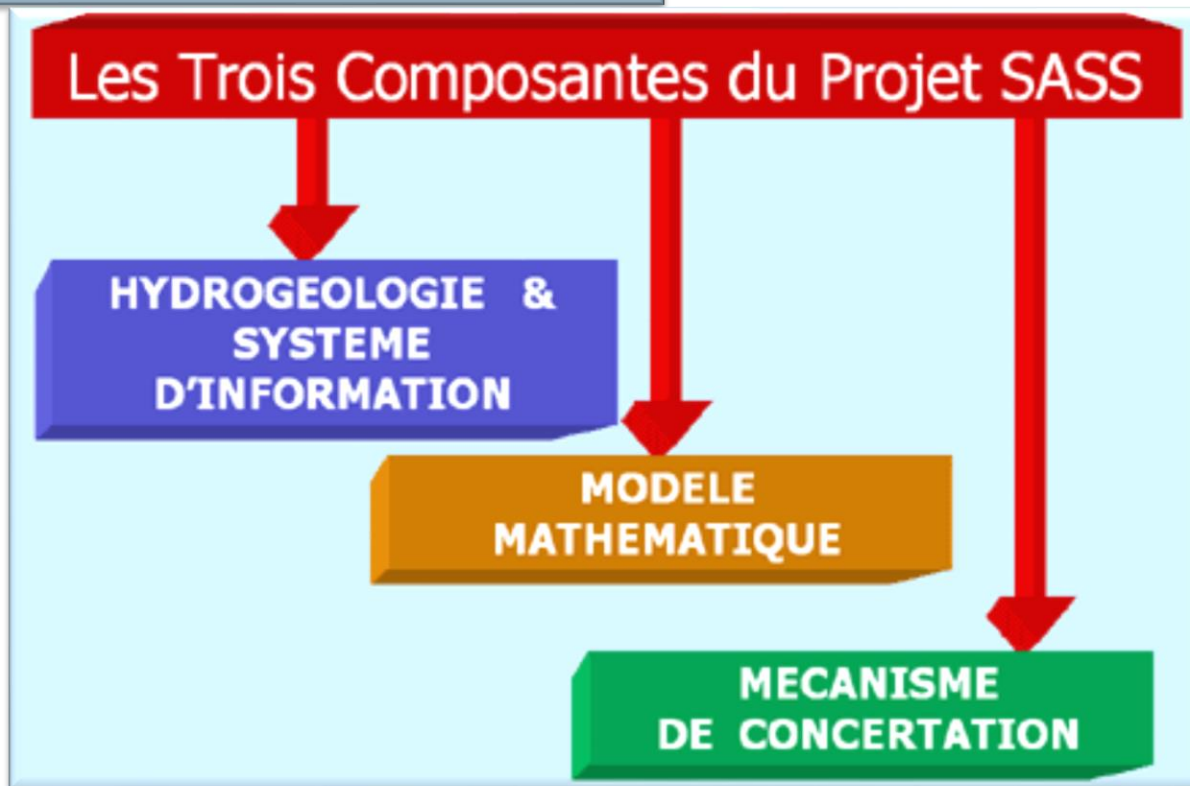


2040





Phase 2: SASS II (2003-2006)



- The elaboration of two sub-models (Biskra and the occidental Basin in Algeria) and the Tunisian-Libyan Jeffara model;
- The establishment of a diagnosis on the agricultural practices in the SASS;
- The setting up of an institutional consultation mechanism (hosted by OSS) between the three countries.

الدول الثلاث انشأت منذ 2008 آلية للتشاور فيما يخص الإدارة والتصرف المشترك لهذا الخزان الجوفي للتعبير عن الإرادة في تجاوز التصرف المنفرد لهذه الموارد وهذه الآلية هي تنسيقية ترأسها كل سنتين دولة وبتمويل بـ 90 الف اورو حصة كل دولة 30 الف اورو





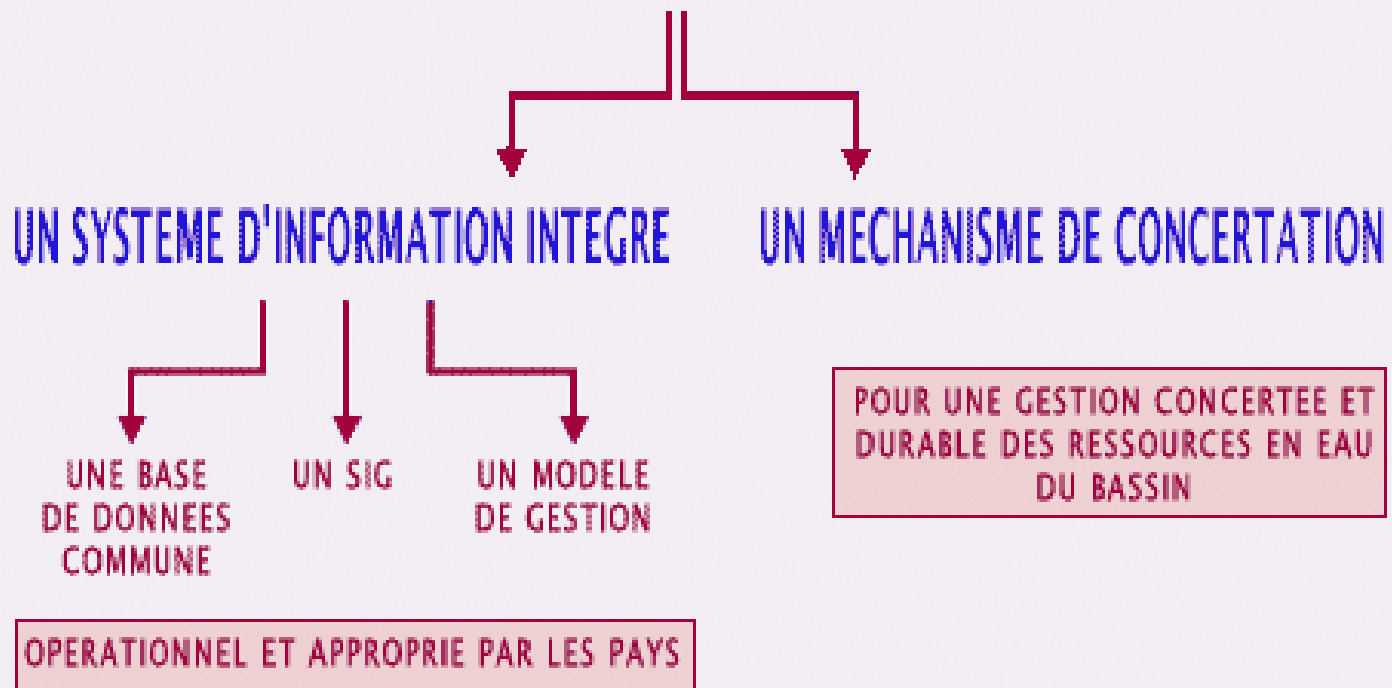
Observatoire du Sahara et du Sahel Sahara and Sahel Observation

North Westh of Sahara Aquifers Systhem NWSAS



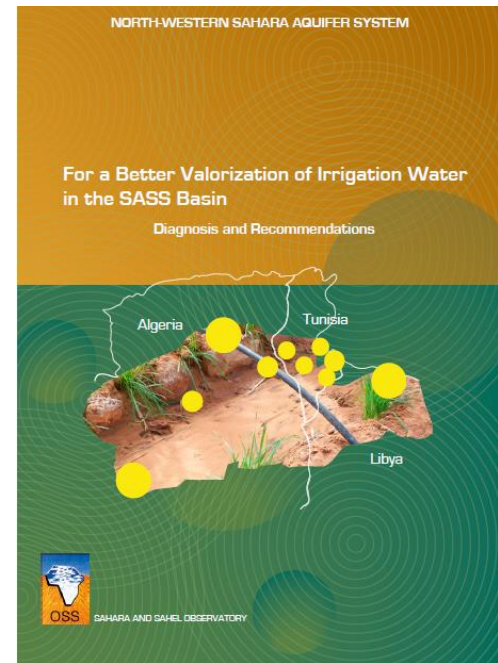
والتنسيقية التي تضم الدول الثلاث وعلى الرغم من انها في قرار انشائها تم التنصيص عن استقلالية قرارها لكنها تعمل اليوم وفق مرصد الصحراء والساحل وممثلة في منسق فقط ومرصد الصحراء والساحل منظمة حكومية دولية ذات بعد أفريقي، أسست سنة 1992 ومقرها بتونس و يتكون من 23 دولة أفريقية عضو، و5 دول أعضاء غير أفريقيين، و10 منظمات دولية (منهم 4 منظمات إقليمية تمثل غرب وشرق وشمال أفريقيا) ومنظمة غير حكومية واحدة

LES RESULTATS DU SASS



Phase 3: SASS III (2009-2014)

The third phase of the SASS project entitled **“Operational recommendations for sustainable water resources management of the North-western Sahara Aquifer System”** has as final outcomes the elaboration of operational recommendations for the utilization, management, and measurement of water extracted for agricultural purposes, notably in the zones where the water, the soil and/or the ecosystem are most vulnerable.



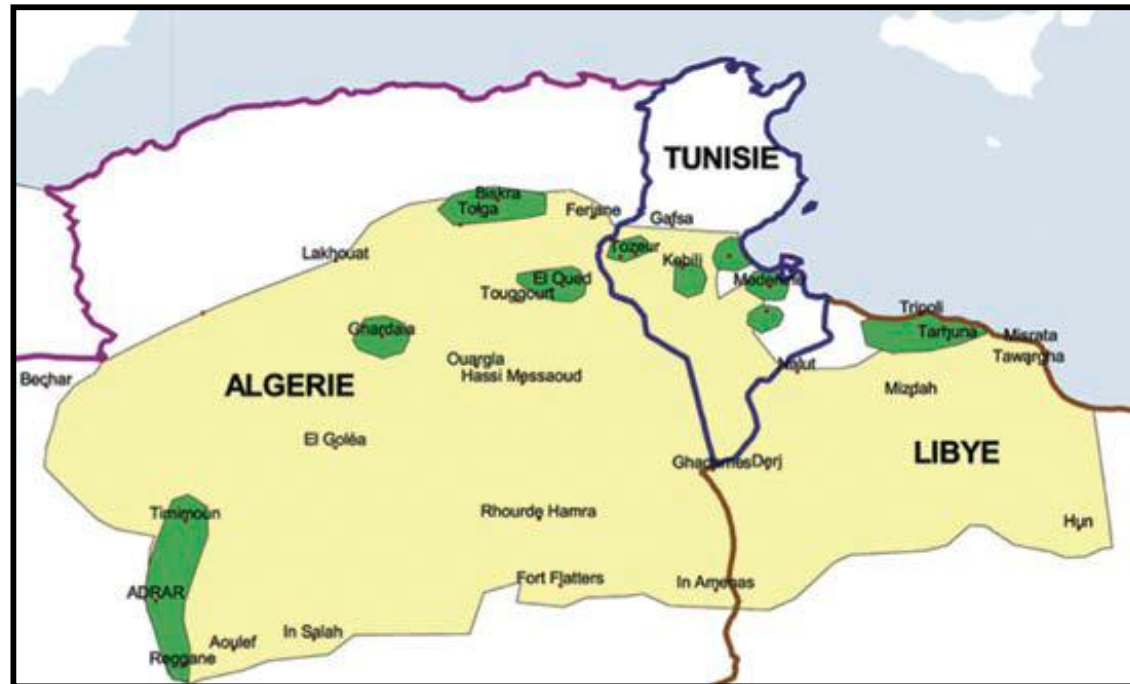
In 2009, OSS launched the second phase of the SASS project which was structured around two main components:

- A “socio-economics” component that has as objective **the analysis and understanding of the irrigator’s behavior** for a better valorization of water resources;
- A “demonstration pilots” component that aimed **to prove the feasibility and acceptability of technical innovations to treat the major issues** of the Saharan agriculture.

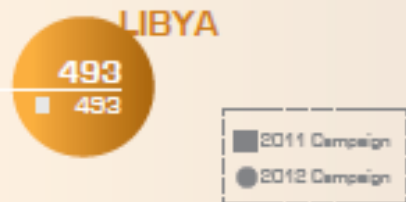
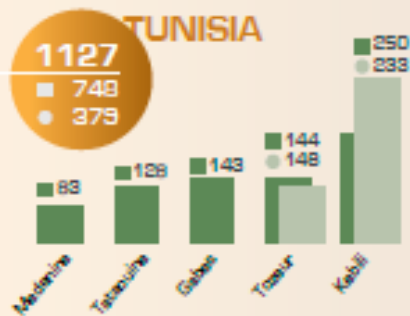
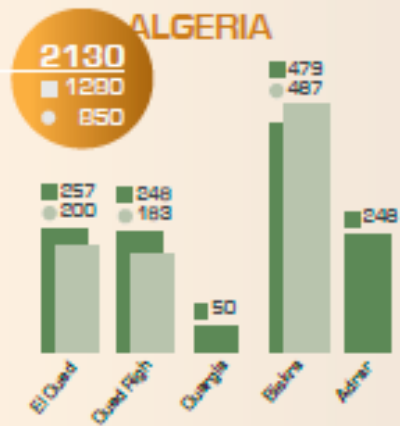
Socio-Economic Aspects

Ten zones were finally retained and further surveys were conducted in the three countries:

- Tunisia: 5 zones: Gabes, Kebili, Tozeur, Medenine, and Tataouine
- Algeria: 4 zones : Biskra, El Oued, Ouagla, Oued el Righ
- Libya : 1 zone : Essouani in the Libyan Jeffara .



Location of the survey zones



Graphique 1. Spatial and temporal distribution of data retained for the analysis.

Methodology

Out of the ten surveyed zones, a sample of three thousand farms was retained based on various criteria ensuring the sample's representativeness of the whole region, including notably **the proportion of irrigated surfaces, the size of farms and the type of access to water.**

Two survey campaigns were conducted on this sample (Graphic 1).

Categories of users and profile of consumptions per country

These results allow to describe the irrigator's behavior per country based on the most relevant variables, notably the **cost born by the irrigator** and the **impacts of water salinity on productivity**.

Three categories of access to water were identified:

The analysis is based on the following economic variables:

	Average SASS	Private access	Public access	Free access	Algeria	Libya	Tunisia
Water consumption per hectare et per farmer (m ³ /ha)	12 686	10 516	14 746	21 735	13 520	9 134	13 266
Water cost (\$/m ³)	0.036	0.045	0.028	0.004	0.036	0.028	0.040
Water productivity (\$/m ³)	0.413	0.484	0.350	0.274	0.405	0.341	0.458
Gross margin per ha	3 909	4 270	3 176	4 683	4 632	2 861	3 478
Importance of breeding (% of the agricultural revenue)	17.72	19.7	12.94	30.85	14.9	27.9	9.4
Average irrigated area (ha)	4.2	6	2.6	0.85	5.1	6	1.8
% of water demand's price elasticity (variation of water consumption when the water price increases by 100%)	-12	-27	-8	-	-45	-25	-33
% of Salinity-elasticity (variation of water productivity when salinity increases by 100%)	-75	-67	-80	-	-53	-52	-35

Summary of results by category of access to water per country

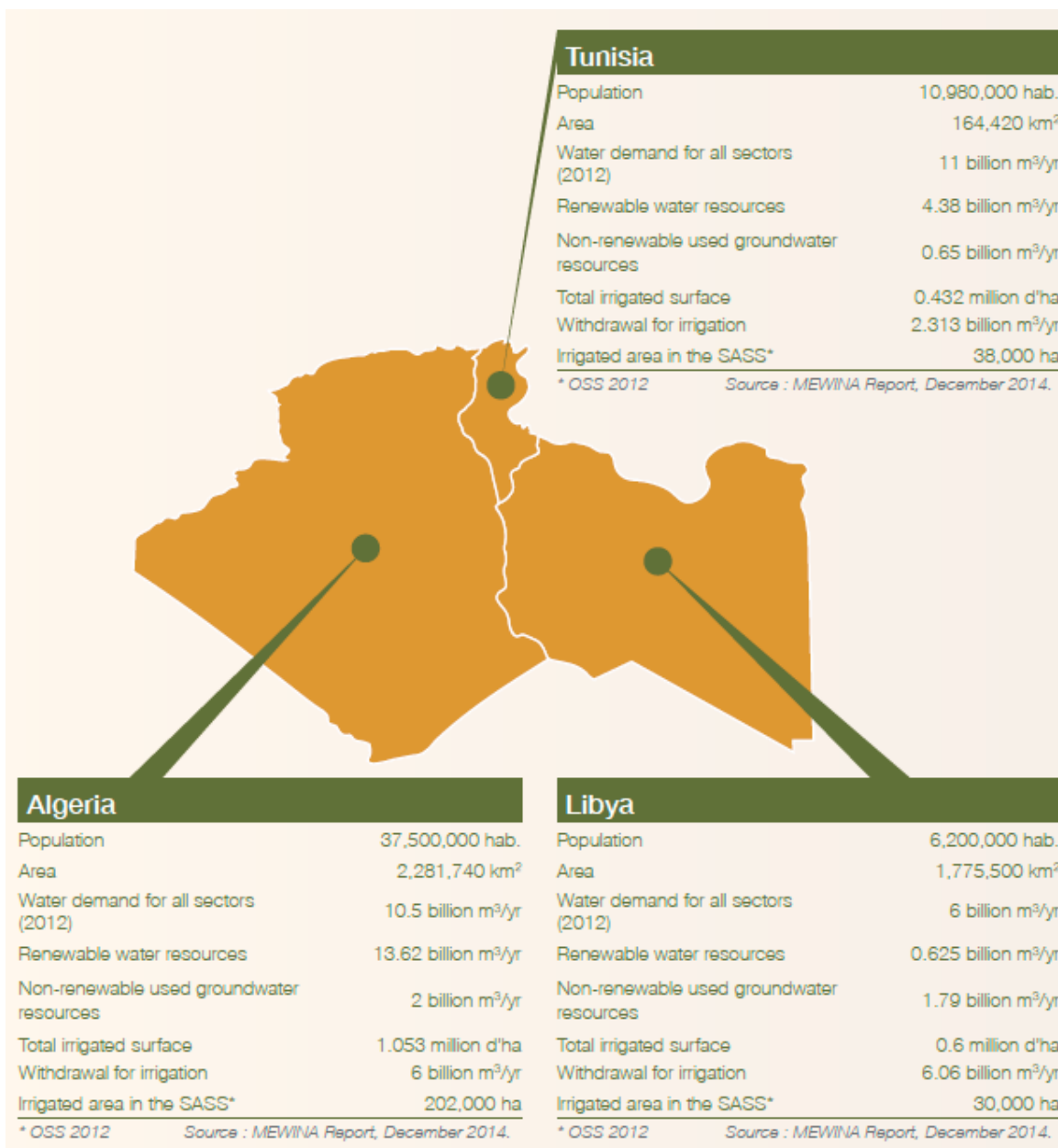
Water Productivity per agricultural system

	Oasis	Open field	Arbo.	Dense oasis	Vegetable crops	Livestock
Surveyed farmers	994	237	386	1409	459	164
Water consumption (m ³ /ha)	10 628	8 371	7 727	16 869	11 920	13 872
Area	3.9	11.6	4.4	2.57	5.32	3.91
Water cost (\$/m ³)	0.036	0.044	0.046	0.029	0.044	0.035
Water productivity (\$/m ³)	0.199	0.344	0.456	0.558	0.574	0.769
Gross margin/ha (\$)	1 827	3 124	3 271	7 548	7 285	11 841

Summary of key findings by production system

These results show that increasing revenues is possible by consuming less water by opting for more adapted agricultural systems.

The results obtained could actually inspire an agricultural policy that aims to encourage the most water-valorizing agricultural systems and to reduce areas allocated to less profitable systems.

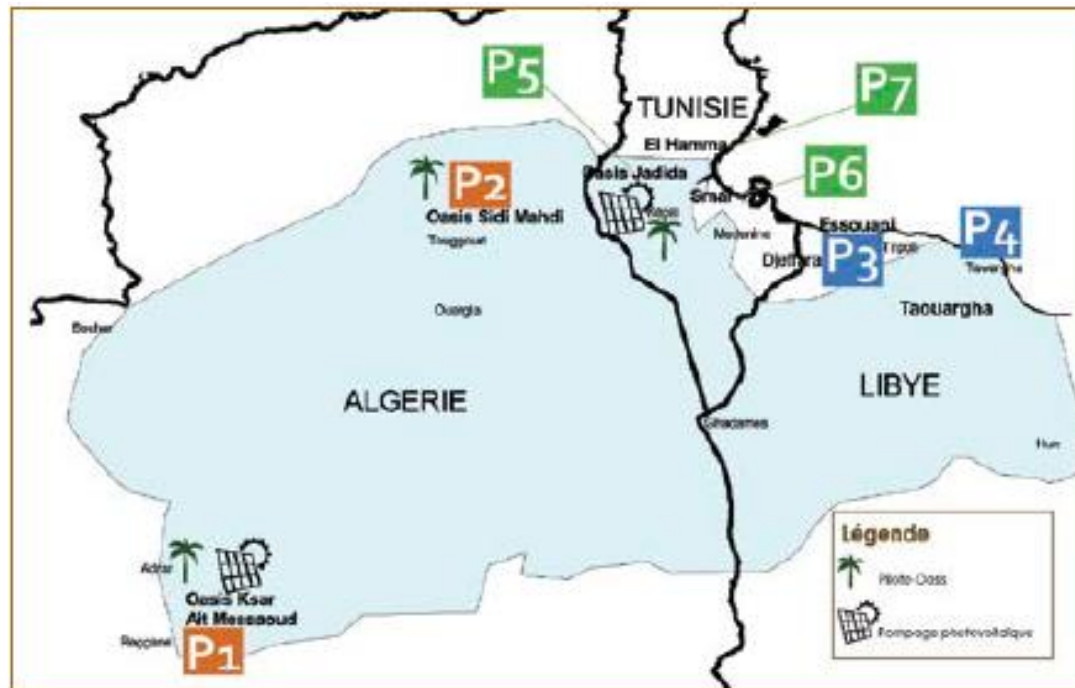


Description of land and water resources in the three countries.

Demonstration Pilots

The agricultural demonstration pilots aimed **to test technical solutions for a better productivity of water** in the SASS basin. These solutions were developed taking into consideration the following:

- the economic profitability of hydro-agricultural structures and systems;
- the improvement of irrigation water productivity;
- the increase of farmers' revenues;
- the preservation of the environment.



Location of the agricultural demonstration pilots.

Six demonstration pilots, featuring four major problems facing the Saharan agriculture, were selected in close collaboration with institutions in charge of water management in the three countries concerned. These issues include mainly:

- **water deficit;**
- **water salinization;**
- **inefficiency of irrigation;**
- **soil degradation.**



The technical innovations adopted at the level of the six pilots to address these issues concern four major themes:

Theme 1: recourse to solar energy

Theme 2: Brackish Water Valorization through demineralization

Theme 3: Rehabilitation of lands degraded due to water stagnation

Theme 4: Irrigation Efficiency and Agricultural Intensification

AGRICULTURAL DEMONSTRATION PILOTS

Pilot 1: Reggane, region of Adrar (Algeria)

The success of this operation triggered a series of discussions and exchanges among local actors focusing on prospects for replicating this pilot in other oases according to modalities that fit the social and community network in the region.

	Issue	Main cropping system	Area	Irrigation mode	Socio-economics
Context	Water deficit Foggaras threatened by depletion	Date palms	1 ha	Gravity irrigation / Flood irrigation	Abandonment of irrigated agriculture

Objectives	Implementation means	Results
<ul style="list-style-type: none"> • Restore the initial flow of "foggaras" to 5 l/s • Save water • Intensify oasis agriculture • Improve revenues 	<ul style="list-style-type: none"> • Allocation of boreholes' water using solar pumping • Water pressurization • Moving from gravity irrigation to drip irrigation 	<ul style="list-style-type: none"> • Implementation of intercrops between date palms • More than 80% of cultivated area • Water economy of 40% • Increase of agricultural yields • Increase of farmers' revenues by 100%



Before



After

Pilot 2 Essouani (Libya)

	Issue	Main cropping system	Area	Irrigation mode	Socio-economics
Context	Water deficit and salinization	Vegetable crops	5 ha including 3 permanently irrigated hectares	Gravity irrigation	Abandonment of agriculture

Objectives	Implementation means	Results
<ul style="list-style-type: none"> • Increase the efficiency of irrigation with brackish water of 1.6g/l salinity and save water • Improve farmers' revenues 	<ul style="list-style-type: none"> • Localized irrigation • Intensification of agricultural systems • Crop rotation irrigated with brackish water • Preventive phyto-sanitary treatment and adapted fertilization • Off-season crops conducted under tunnels and in open fields 	<ul style="list-style-type: none"> • Yield of 85 tons for 2.8 ha in 2012 compared to 25 tons for the highest production registered in previous years • Revenues of 28 225 € compared to 7000 € for the best revenues registered in previous years • Intensification of agriculture (intercropping)



Before



After

Pilot 3 Medenine (Tunisia)

	Issue	Main cropping system	Area	Irrigation mode	Socio-economics
Context	<ul style="list-style-type: none"> Water deficit Water salinization (4g/l) Reduction of rangelands 	<ul style="list-style-type: none"> Olive cultivation Vegetable crops 	1,2 ha	Family wells	<ul style="list-style-type: none"> Abandonment of agriculture Immigration Rural exodus

Objectives	Implementation means	Results
<ul style="list-style-type: none"> Desalinate Water for irrigation Improve irrigation efficiency Improve agricultural yields and revenues 	<ul style="list-style-type: none"> Development of plots Desalination station Construction of a basin Pressurization pump Localized irrigation network Installation of two greenhouses 	<ul style="list-style-type: none"> Water saving and water production by mixing treated and non-treated waters Efficiency of the localized irrigation of olives Increase of cultivated area to 1.38 ha Increase of agricultural intensification from 25% to 131.6 %



Before



After

Projet Nexus: Renforcement de la coopération transfrontière de l'eau au niveau du SASS

Une expérience pionnière au niveau de la gestion durable des ressources en eau dans la zone SASS est en cours de mise en œuvre dans le cadre du projet NEXUS qui a démarré en janvier 2017. Il s'agit du renforcement de la coopération transfrontière de l'eau au niveau du Système Aquifère du Sahara Septentrional- SASS", dans le cadre d'une vision globale Eau, Energie, Alimentation, Ecosystèmes. Ce projet régional, qui vise à renforcer la coordination institutionnelle et une vision commune à travers un dialogue régional sur le Nexus dans le contexte transfrontalier

Global Water Partnership Méditerranée (GWP-Med)

l'agence suédoise de coopération internationale au développement (SIDA)



Thank You Very Much For Your Attention