THE GLOBAL DOG RABIES ELIMINATION PATHWAY

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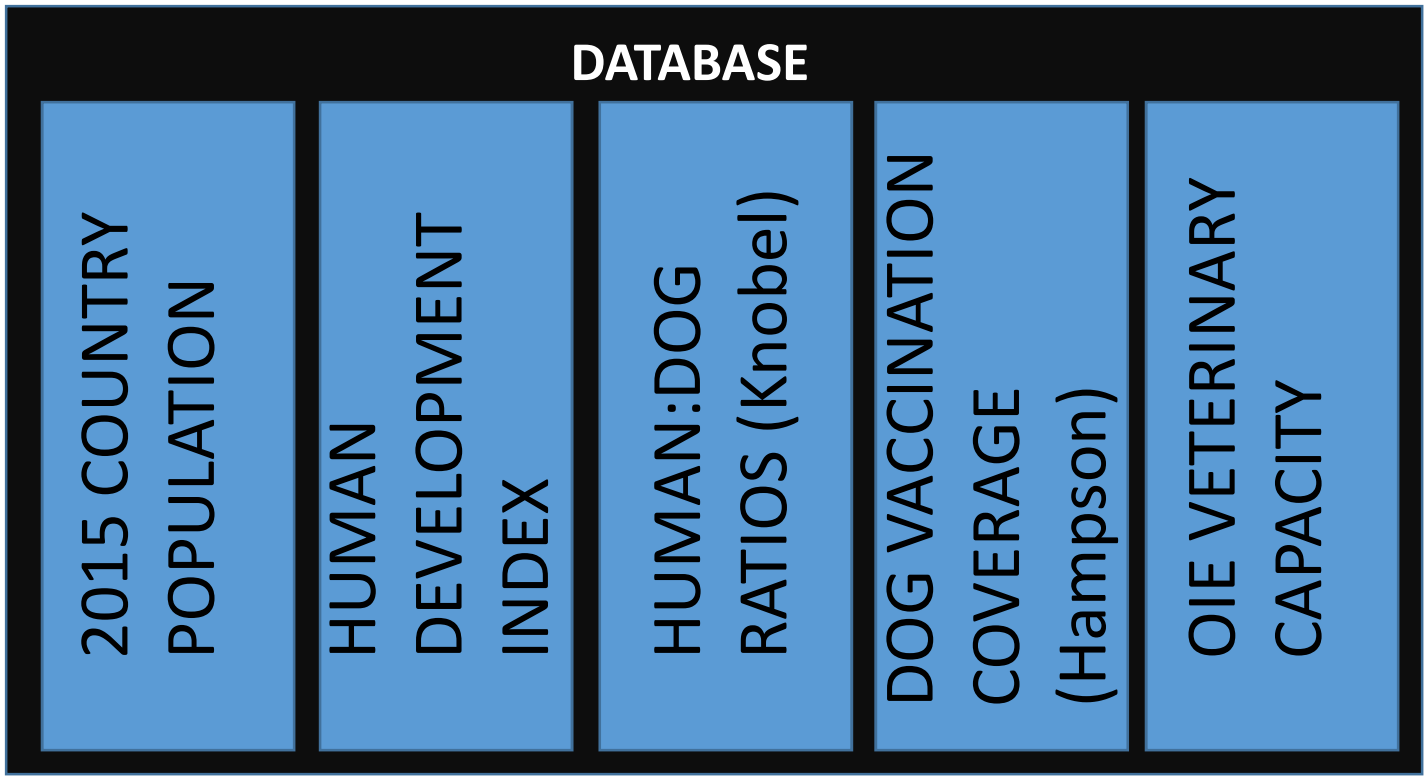
Photo credit: GARC

Global Needs Assessment

1. What **infrastructure** do we need?
2. How many **dogs** do we have?
3. How much **vaccine** will we need?
4. How many **vaccinators** do we need?
5. How much will this **cost**?

Identifying global data sources



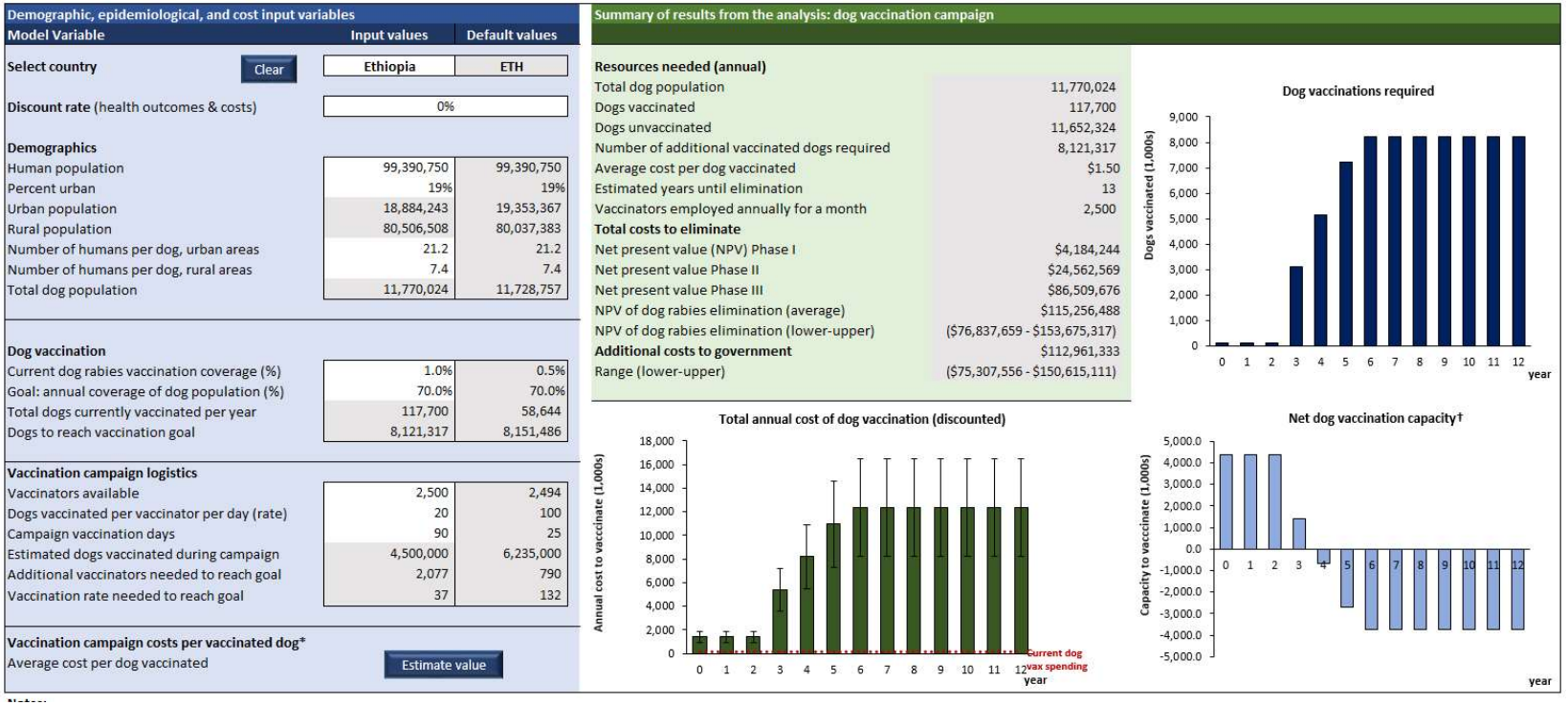
Country	Continent	Cluster	World Bank Human Population 2	Percent Urban	Human Development Index	Canine Rabies Hosp	Canine Rabies	Entire Country Affect	Urban Population Affec	Rural Population Affec	Total Population Affec	Urban H:D Ratio (Da	Rural H:D Ratio (Da	Urban H:D Ratio (Kno
Afghanistan	Asia	Eurasia	32,526,562	26.703	0.398	1			8,685,568	23,840,994				7.5
Albania	Europe	EasternEurope	2,889,167	57.407	0.739	1			1,658,584	1,230,583				6.5
Algeria	Africa	North Africa	39,666,519	70.727	0.698	1			28,054,939	11,611,580				21.2
Angola	Africa	Congo Basin	25,021,974	44.05	0.486	1			11,022,180	13,999,794				21.2
Argentina	Americas	Southern Cone	43,416,755	91.751	0.797	1			39,835,307	3,581,448				7.5
Armenia	Europe	EasternEurope	3,017,712	62.673	0.716	1			1,891,291	1,126,421				6.5
Azerbaijan	Europe	Eurasia	9,651,349	54.62	0.731	1			5,271,567	4,379,782				6.5
Bahrain	Asia	Middle East	1,377,237	88.775	0.806	1			1,222,642	154,595				7.5
Bangladesh	Asia	Asia 3	160,995,642	34.277	0.5	1			55,184,476	105,811,166				7.5
Belarus	Europe	EasternEurope	9,513,000	76.667	0.756	1			7,293,332	2,219,668				6.5
Benin	Africa	West Africa	10,879,829	43.95	0.427	1			4,781,685	6,098,144				21.2
Bhutan	Asia	Asia 3	774,830	38.644	0.522	1			299,425	475,405				7.5
Bolivia	Americas	Andean	10,724,705	68.512	0.663	1			7,347,710	3,376,995		4.6		7.5
Bosnia and Herzegovina	Europe	EasternEurope	3,810,416	39.767	0.733	1			1,515,288	2,295,128				6.5
Botswana	Africa	SADC	2,262,485	57.444	0.633	1			1,299,662	962,823				21.2
Brazil	Americas	Brazil	207,847,528	85.687	0.718	1			178,098,311	29,749,217				7.5
Bulgaria	Europe	EasternEurope	7,177,991	73.948	0.771	1			5,307,981	1,870,010				6.5
Burkina Faso	Africa	West Africa	18,105,570	29.859	0.331	1			5,406,142	12,699,428				21.2
Burundi	Africa	Congo Basin	11,178,921	12.057	0.316	1			1,347,843	9,831,078				21.2
C_te d'Ivoire	Africa	West Africa	22,701,556	54.18	0.4	1			12,299,703	10,401,853				21.2
Cambodia	Asia	Asia 2	15,577,899	20.723	0.523	1			3,228,208	12,349,691				7.5
Cameroon	Africa	West Africa	23,344,179	54.381	0.482	1			12,694,798	10,649,381				21.2
Central African Republic	Africa	Congo Basin	4,900,274	40.037	0.343	1			1,961,923	2,938,351				21.2
Chad	Africa	West Africa	14,037,472	22.471	0.328	1			3,154,360	10,883,112				21.2
China	Asia	China	1,371,220,000	55.614	0.687	1			762,590,291	608,629,709				48.3
Colombia	Americas	Andean	48,228,704	76.436	0.71	1			36,864,092	11,364,612				7.5
Congo	Africa	Congo Basin	4,620,330	65.38	0.533	1			3,020,772	1,599,558				21.2
Croatia	Europe	EasternEurope	4,224,404	58.964	0.796	1			2,490,878	1,733,526				6.5
Cuba	Americas	Caribbean	11,389,562	77.074	0.776	1			8,778,391	2,611,171				7.5
Czech Republic	Europe	EasternEurope	10,551,219	72.992	0.865	1			7,701,546	2,849,673				6.5
Democratic People's Republic of	Asia	Asia 2	25,155,317	60.875	0.766	1			15,313,299	9,842,018				7.5
Democratic Republic of the Cong	Africa	Congo Basin	77,266,814	42.494	0.286	1			32,833,760	44,433,054				21.2
Djibouti	Africa	North Africa	887,861	77.343	0.43	1			686,698	201,163				21.2
Dominican Republic	Americas	Caribbean	10,528,391	78.98	0.689	1			8,315,323	2,213,068				7.5
Ecuador	Americas	Andean	16,144,363	63.742	0.72	1			10,290,740	5,853,623		7.2		7.5
Egypt	Africa	North Africa	91,508,084	43.135	0.644	1			39,472,012	52,036,072				21.2
El Salvador	Americas	Central America & Mexico	6,126,583	66.726	0.674	1			4,088,024	2,038,559				7.5
Equatorial Guinea	Africa	Congo Basin	845,060	39.923	0.537	1			337,373	507,687				21.2
Eritrea	Africa	North Africa	5,222,000	37.7	0.349	1			1,968,694	3,253,306				21.2
Estonia	Europe	EasternEurope	1,311,998	67.538	0.835	1			886,097	425,901				6.5
Ethiopia	Africa	SADC	99,390,750	19.472	0.363	1			19,353,367	80,037,383				21.2
Gabon	Africa	Congo Basin	1,725,292	87.156	0.674	1			1,503,695	221,597				21.2
Gambia	Africa	West Africa	1,990,924	59.632	0.42	1			1,187,228	803,696				21.2
Georgia	Europe	Eurasia	3,679,000	53.641	0.733	1			1,973,452	1,705,548				6.5
Ghana	Africa	West Africa	27,409,893	54.042	0.541	1			14,812,854	12,597,039				21.2
Guatemala	Americas	Central America & Mexico	16,342,897	51.571	0.574	1			8,428,195	7,914,702				7.5
Guinea	Africa	Congo Basin	12,608,590	37.161	0.344	1			4,685,478	7,923,112				21.2
Guinea-Bissau	Africa	West Africa	1,844,325	49.332	0.353	1			909,842	934,483				21.2
Guyana	Americas	Central America & Mexico	767,085	28.553	0.633	1			219,026	548,059				7.5
Haiti	Americas	Caribbean	10,711,067	58.645	0.454	1			6,281,505	4,429,562				7.5
Honduras	Americas	Central America & Mexico	8,075,060	54.73	0.625	1			4,419,480	3,655,580				7.5
Hungary	Europe	EasternEurope	9,844,686	71.227	0.816	1			7,012,074	2,832,612				6.5
India	Asia	India	1,311,050,527	32.747	0.547	1			429,329,716	881,720,811		12.0 - 35.0	37	7.5

Establishing a Framework

Global Dog Rabies Elimination Pathway (GDREP)

Implementation Phase:	**Phase I: Preparation**			**Phase II: Scale-up dog vaccination**			**Phase III: Sustained 70% dog vaccination**						
Program year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Expected dog vax coverage:	<18%			18% - 35%	35% - 53%	53% - 70%	>70%						
Activities acheived:	Field studies			Pilot implementation			Mass vaccination of dogs						
	Strengthening lab capacity			Scaling-up vaccination coverage			Surveillance to establish disease freedom						
	Workforce training			Logistical improvements									
				Operational equipment									

Customizable GDREP Tool



Demographic, epidemiological, and cost input variables

Model Variable		Input values	Default values
Select country	Clear	Ethiopia	ETH
Discount rate (health outcomes & costs)		0%	
Demographics			
Human population		99,390,750	99,390,750
Percent urban		19%	19%
Urban population		18,884,243	19,353,367
Rural population		80,506,508	80,037,383
Number of humans per dog, urban areas		21.2	21.2
Number of humans per dog, rural areas		7.4	7.4
Total dog population		11,770,024	11,728,757
Dog vaccination			
Current dog rabies vaccination coverage (%)		1.0%	0.5%
Goal: annual coverage of dog population (%)		70.0%	70.0%
Total dogs currently vaccinated per year		117,700	58,644
Dogs to reach vaccination goal		8,121,317	8,151,486
Vaccination campaign logistics			
Vaccinators available		2,500	2,494
Dogs vaccinated per vaccinator per day (rate)		20	100
Campaign vaccination days		90	25
Estimated dogs vaccinated during campaign		4,500,000	6,235,000
Additional vaccinators needed to reach goal		2,077	790
Vaccination rate needed to reach goal		37	132
Vaccination campaign costs per vaccinated dog*			
Average cost per dog vaccinated	Estimate value		

Summary of results from the analysis: dog vaccination campaign

Resources needed (annual)	
Total dog population	11,770,024
Dogs vaccinated	117,700
Dogs unvaccinated	11,652,324
Number of additional vaccinated dogs required	8,121,317
Average cost per dog vaccinated	$1.50
Estimated years until elimination	13
Vaccinators employed annually for a month	2,500
Total costs to eliminate	
Net present value (NPV) Phase I	$4,184,244
Net present value Phase II	$24,562,569
Net present value Phase III	$86,509,676
NPV of dog rabies elimination (average)	$115,256,488
NPV of dog rabies elimination (lower-upper)	($76,837,659 - $153,675,317)
Additional costs to government	$112,961,333
Range (lower-upper)	($75,307,556 - $150,615,111)

- **INPUT**
  - Country-specific parameters
  - Direct comparison to values used in GDREP
- **OUTPUT**
  - Time to elimination
  - Vaccination personnel needed
  - Cost to eliminate

GDREP Example: Kenya

Demographic, epidemiological, and cost input variables		
Model Variable	**Input values**	**Default values**
Select country (Clear)	Kenya	KEN
Discount rate (health outcomes & costs)	3%	
Demographics		
Human population	46,050,302	46,050,302
Percent urban	26%	26%
Urban population	11,973,079	11,799,008
Rural population	34,077,223	34,251,294
Number of humans per dog, urban areas	21.2	21.2
Number of humans per dog, rural areas	7.4	7.4
Total dog population	5,169,798	5,185,110
Dog vaccination		
Current dog rabies vaccination coverage (%)	11.0%	0.5%
Goal: annual coverage of dog population (%)	70.0%	70.0%
Total dogs currently vaccinated per year	568,678	25,926
Dogs to reach vaccination goal	3,050,181	3,603,652
Vaccination campaign logistics		
Vaccinators available	1,207	1,207
Dogs vaccinated per vaccinator per day (rate)	100	100
Campaign vaccination days	25	25
Estimated dogs vaccinated during campaign	3,017,500	3,017,500
Additional vaccinators needed to reach goal	241	245
Vaccination rate needed to reach goal	120	120
Vaccination campaign costs per vaccinated dog*		
Average cost per dog vaccinated	(Estimate value)	

GDREP:
Audience and Goals

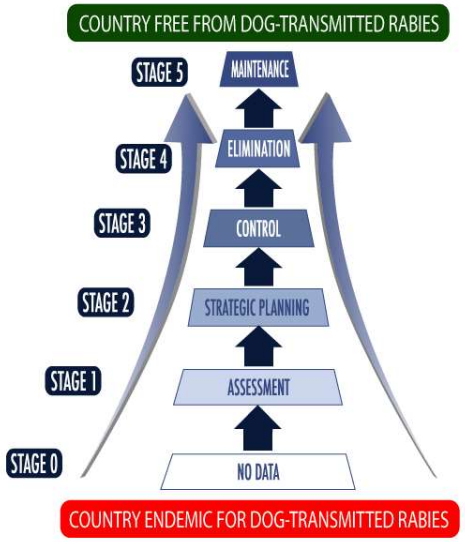
- Who is the intended audience?
  - High-level stakeholders, policy-makers, national rabies control programs

- What are the goals?
  - Highlight the monetary and fiscal commitment that are required for rabies elimination
  - Initiate discussions about funding continuity
  - Establish a strong foundation for multi-year government commitment

How to access and utilize the GDREP

- **Workshops**

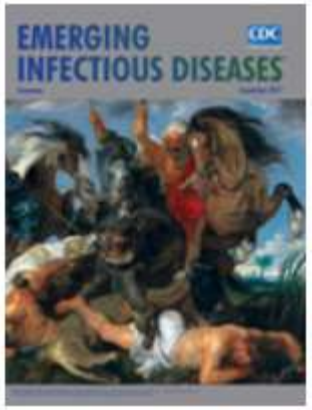
- **SARE**



- **On line**

canine**rabies**blueprint.org

a blueprint for the control of rabies
in dog populations



Thank you!

- Government Partners
  - Haiti Ministry of Agriculture
  - Haiti Ministry of Health
  - Ethiopia Public Health Institute
  - Ethiopia Ministry of Livestock and Fisheries
  - Vietnam Department of Animal Health
  - Kenya ZDU
- Universities
  - University of the Valley – Guatemala
  - Ohio State University
  - Georgia State University
- Partners
  - GARC
  - Christian Veterinary Mission
  - Mission Rabies
  - Humane Society International
  - World Health Organization
  - OIE
  - PAHO

Vaccine Calculator

- GDREP is a ***broad*** estimate
- How do you make it easier to plan a successful ***local*** campaign?
- **Dog populations** differ between communities
- **Vaccination methods** are more appropriate in certain settings
- **Costs** vary between programs

Different Dog Populations

Never Confined

Semi-Confined

Confined

Different Dog Populations

Never Confined

Semi-Confined

Confined

Vaccine accessibility by dog population

Ownership	Confinement Status	Contribution to Enzootic Rabies Transmission	Vaccination Strategy Accessibility: Central Point	Door-to-Door	CVR	ORV
Family Owned	Always Confined	LOW	HIGH	HIGH	LOW	HIGH
	Sometimes Confined	MEDIUM	HIGH	MEDIUM	MEDIUM	HIGH
	Never Confined	HIGH	LOW	LOW	HIGH	HIGH
Community Owned	Sometimes Confined	MEDIUM	MEDIUM	LOW	MEDIUM	HIGH
	Never Confined	HIGH	LOW	LOW	HIGH	HIGH
Feral	Never Confined	HIGH	LOW	LOW	HIGH	MEDIUM

Mass Vaccination Calculator: a planning aid

Central Point

Door to Door

Capture/Vaccinate/Release

Oral Vaccination

Vaccination Program Calculator

Required input

Dog population

Number of dogs in program area (n, %)	100,000	100.0%
Confined dogs (n, %)	20,000	20.0%
Sometimes confined dogs (n, %)	50,000	50.0%
Never confined dogs (n, %)	30,000	30.0%

Dog vaccination campaign

Parenteral vaccines procured (number)	55,000	100.0%
Oral vaccines procured (number)	15,000	
Vaccination strategy (doses)		
CP Central Point	50,000	71.4%
DD Door to Door	0	0.0%
CVR Capture, Vaccinate, Release	5,000	7.1%
ORV Oral Vaccine Handouts	15,000	21.4%

Expected Vaccination Coverage by Method †

	Vaccination strategy*			
	CP	DD	CVR	ORV
Confined	60%	60%	20%	20%
Sometimes Confined	40%	80%	60%	40%
Never Confined	20%	20%	40%	60%

How confident are you in your responses to the probability table? 6

Suggested values for probability table

Current country vaccination coverage (%)	55%
GDREP§ phase:	Phase II

Suggested values:	CP	DD	CVR	ORV
Confined	80%	80%	20%	20%
Sometimes Confined	60%	60%	80%	60%
Never Confined	20%	20%	60%	80%

Vaccination campaign costs per vaccinated dog†

Average cost per dog vaccinated — Estimate value

Results: calculated values

Vaccination Doses by Strategy

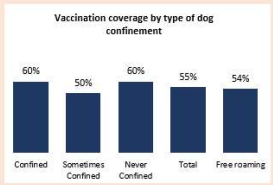
		Procured	Used	Unused
Central Point	**CP**	50,000	38,000	12,000
Door to Door	**DD**	-	-	-
Capture, Vaccinate, Release	**CVR**	5,000	5,000	-
Oral Vaccine Handouts	**ORV**	15,000	12,000	3,000

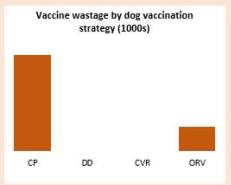
Vaccination doses by Dog Type	Vaccinated	Unvaccinated	Percent	Confidence Lower	Confidence Upper
Confined	12,000	8,000	60.0%	56.0%	64.0%
Sometimes Confined	25,000	25,000	50.0%	46.0%	54.0%
Never Confined	18,000	12,000	60.0%	56.0%	64.0%

Results	Dogs	Vaccinated	Percent	Lower	Upper
Total	100,000	55,000	55.0%	51.0%	59.0%
Free roaming	80,000	43,000	53.8%	49.7%	57.8%

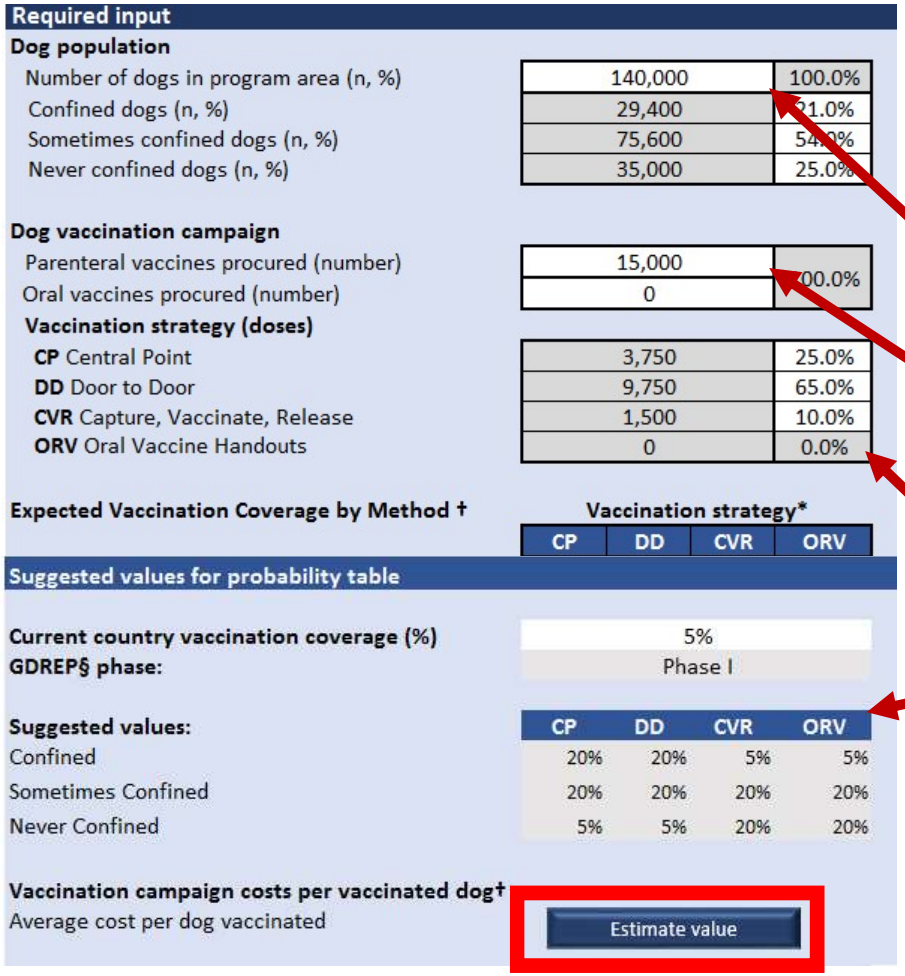
	Procured	Used	Unused	Lower	Upper
Vaccine utilization	70,000	78.6%	21.4%	15.6%	27.2%

Economic costs	Total ($)
Cost per dog vaccinated	$ 4.15
Total Campaign Cost	$ 228,365
Lower bound	$ 164,188
Upper bound	$ 293,810





INPUT: Design your



Required input

Dog population

Number of dogs in program area (n, %)	140,000	100.0%
Confined dogs (n, %)	29,400	21.0%
Sometimes confined dogs (n, %)	75,600	54.0%
Never confined dogs (n, %)	35,000	25.0%

Dog vaccination campaign

Parenteral vaccines procured (number)	15,000	
Oral vaccines procured (number)	0	100.0%

Vaccination strategy (doses)

CP Central Point	3,750	25.0%
DD Door to Door	9,750	65.0%
CVR Capture, Vaccinate, Release	1,500	10.0%
ORV Oral Vaccine Handouts	0	0.0%

Expected Vaccination Coverage by Method †

Vaccination strategy*

CP	DD	CVR	ORV

Suggested values for probability table

Current country vaccination coverage (%)	5%
GDREP§ phase:	Phase I

Suggested values:	CP	DD	CVR	ORV
Confined	20%	20%	5%	5%
Sometimes Confined	20%	20%	20%	20%
Never Confined	5%	5%	20%	20%

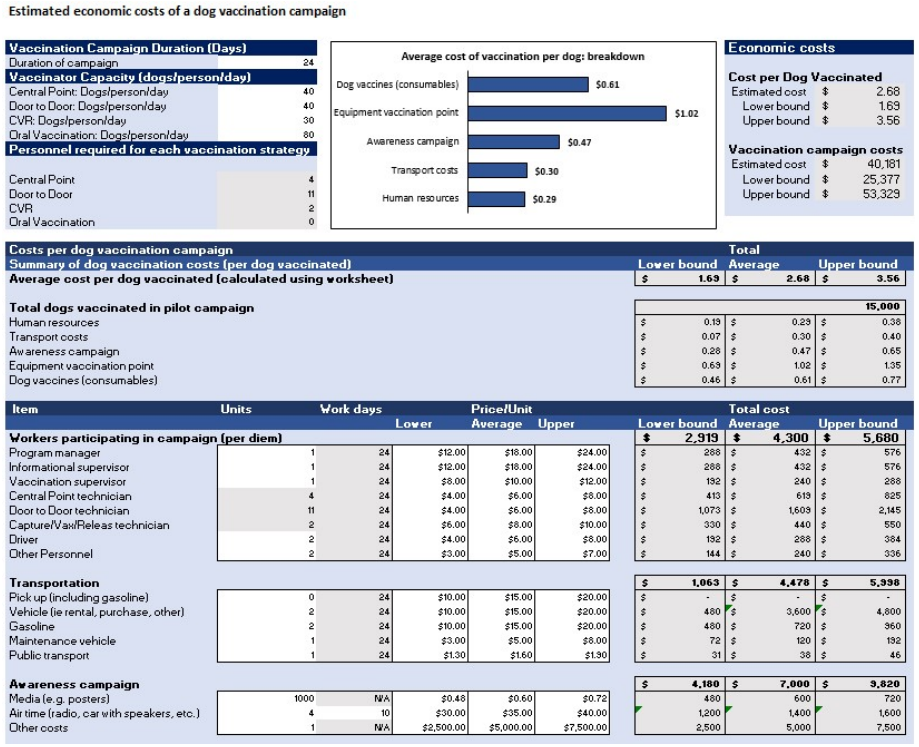
Vaccination campaign costs per vaccinated dog†

Average cost per dog vaccinated

Estimate value

- Design your own campaign
- Enter your dog population
- Enter the vaccines you will procure
- Enter the vaccine methods you choose
- Estimate the success of those methods

INPUT: Estimate your costs



Estimated economic costs of a dog vaccination campaign

Vaccination Campaign Duration (Days)	
Duration of campaign	24
Vaccinator Capacity (dogs/person/day)	
Central Point: Dogs/person/day	40
Door to Door: Dogs/person/day	40
CVR: Dogs/person/day	30
Oral Vaccination: Dogs/person/day	80
Personnel required for each vaccination strategy	
Central Point	4
Door to Door	11
CVR	2
Oral Vaccination	0

Economic costs		
Cost per Dog Vaccinated		
Estimated cost	$	2.68
Lower bound	$	1.69
Upper bound	$	3.56
Vaccination campaign costs		
Estimated cost	$	40,181
Lower bound	$	25,377
Upper bound	$	53,329

Costs per dog vaccination campaign	Total		
Summary of dog vaccination costs (per dog vaccinated)	**Lower bound**	**Average**	**Upper bound**
Average cost per dog vaccinated (calculated using worksheet)	**$ 1.69**	**$ 2.68**	**$ 3.56**
Total dogs vaccinated in pilot campaign			**15,000**
Human resources	$ 0.19	$ 0.29	$ 0.38
Transport costs	$ 0.07	$ 0.30	$ 0.40
Awareness campaign	$ 0.28	$ 0.47	$ 0.65
Equipment vaccination point	$ 0.69	$ 1.02	$ 1.35
Dog vaccines (consumables)	$ 0.46	$ 0.61	$ 0.77

Item	Units	Work days	Price/Unit			Total cost		
			Lower	Average	Upper	Lower bound	Average	Upper bound
Workers participating in campaign (per diem)						**$ 2,919**	**$ 4,300**	**$ 5,680**
Program manager	1	24	$12.00	$18.00	$24.00	$ 288	$ 432	$ 576
Informational supervisor	1	24	$12.00	$18.00	$24.00	$ 288	$ 432	$ 576
Vaccination supervisor	1	24	$8.00	$10.00	$12.00	$ 192	$ 240	$ 288
Central Point technician	4	24	$4.00	$6.00	$8.00	$ 413	$ 619	$ 825
Door to Door technician	11	24	$4.00	$6.00	$8.00	$ 1,073	$ 1,609	$ 2,145
Capture/Vax/Releas technician	2	24	$6.00	$8.00	$10.00	$ 330	$ 440	$ 550
Driver	2	24	$4.00	$6.00	$8.00	$ 192	$ 288	$ 384
Other Personnel	2	24	$3.00	$5.00	$7.00	$ 144	$ 240	$ 336
Transportation						**$ 1,063**	**$ 4,478**	**$ 5,998**
Pick up (including gasoline)	0	24	$10.00	$15.00	$20.00	$ -	$ -	$ -
Vehicle (ie rental, purchase, other)	2	24	$10.00	$15.00	$20.00	$ 480	$ 3,600	$ 4,800
Gasoline	2	24	$10.00	$15.00	$20.00	$ 480	$ 720	$ 960
Maintenance vehicle	1	24	$3.00	$5.00	$8.00	$ 72	$ 120	$ 192
Public transport	1	24	$1.30	$1.60	$1.90	$ 31	$ 38	$ 46
Awareness campaign						**$ 4,180**	**$ 7,000**	**$ 9,820**
Media (e.g. posters)	1000	N/A	$0.48	$0.60	$0.72	480	600	720
Air time (radio, car with speakers, etc.)	4	10	$30.00	$35.00	$40.00	1,200	1,400	1,600
Other costs	1	N/A	$2,500.00	$5,000.00	$7,500.00	2,500	5,000	7,500

- Estimate the cost to run your campaign!
- Change costs to improve efficiency
- Change duration of your campaign
- Customizable
- Identifies where bulk of costs are allocated

OUTPUT: Will this be a successful campaign?

Results: calculated values

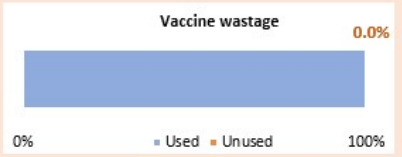
Vaccination Doses by Strategy		Procured	Used	Unused
Central Point	CP	3,750	3,750	-
Door to Door	DD	9,750	9,750	-
Capture, Vaccinate, Release	CVR	1,500	1,500	-
Oral Vaccine Handouts	ORV	-	-	-

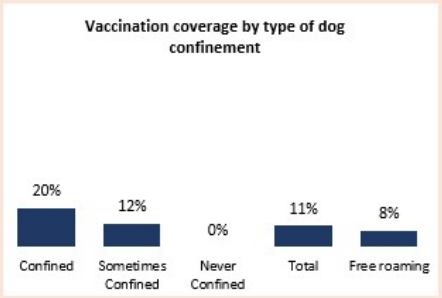
Vaccination doses by Dog Type	Vaccinated	Unvaccinated	Percent	Confidence Lower	Confidence Upper
Confined	5,880	23,520	20.0%	13.9%	26.1%
Sometimes Confined	9,120	66,480	12.1%	6.0%	18.1%
Never Confined	0	35,000	0.0%	0.0%	0.0%

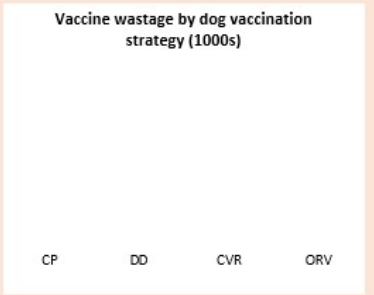
Results	Dogs	Vaccinated	Percent	Lower	Upper
Total	140,000	15,000	10.7%	6.2%	15.3%
Free roaming	110,600	9,120	8.2%	4.1%	12.4%

	Procured	Used	Unused	Lower	Upper
Vaccine utilization	15,000	100.0%	0.0%	0.0%	42.5%

Economic costs	Total ($)
Cost per dog vaccinated	$ 2.68
Total Campaign Cost	$ 40,181
Lower bound	$ 25,377
Upper bound	$ 53,329



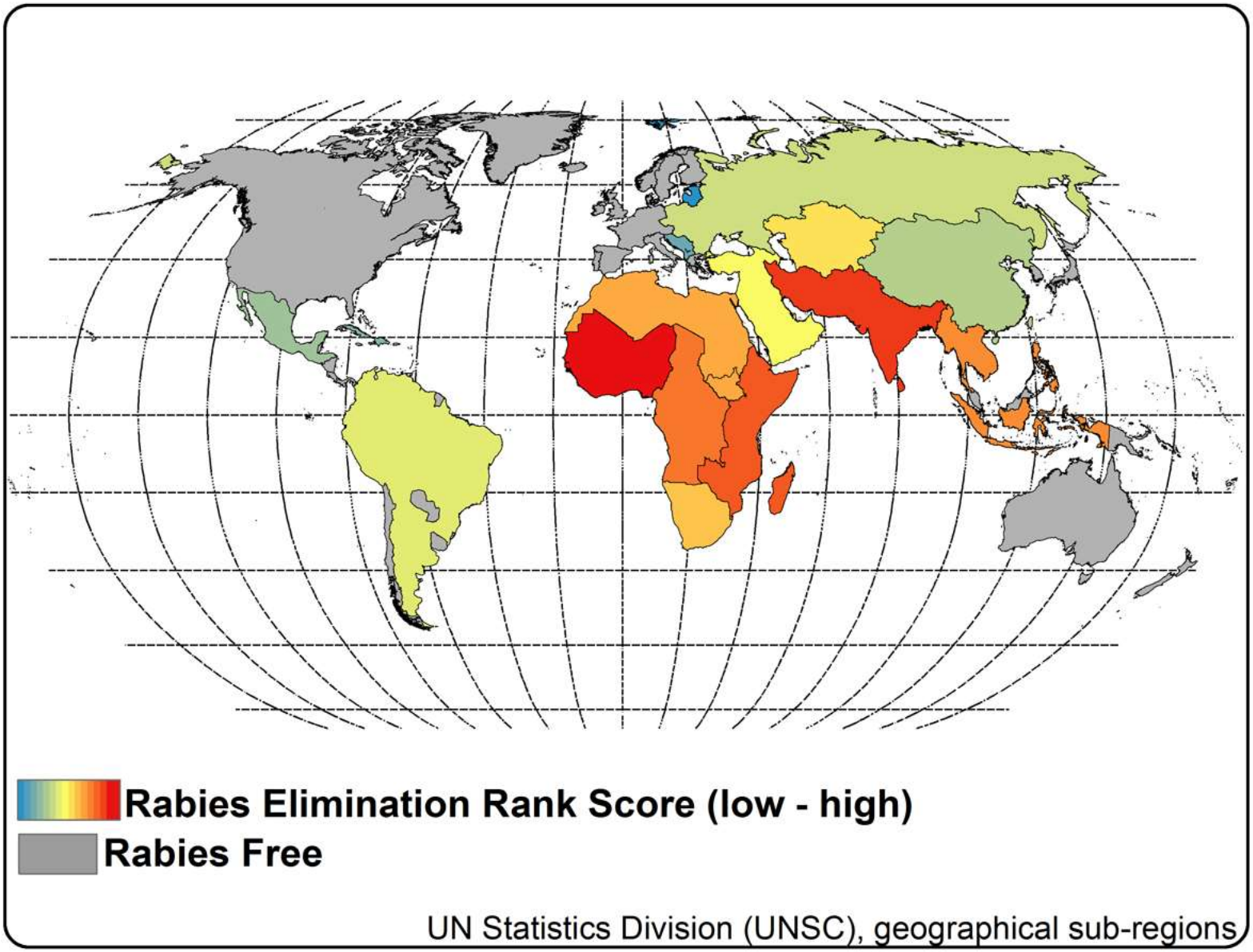




- Predicts:
  - Utilization of vaccine doses by vaccination method
  - Expected vaccine wastage
  - Vaccination coverage in Confined and Free-Roaming dogs
  - Total vaccination coverage
  - Cost per dog Vaccinated
  - Total Campaign Cost

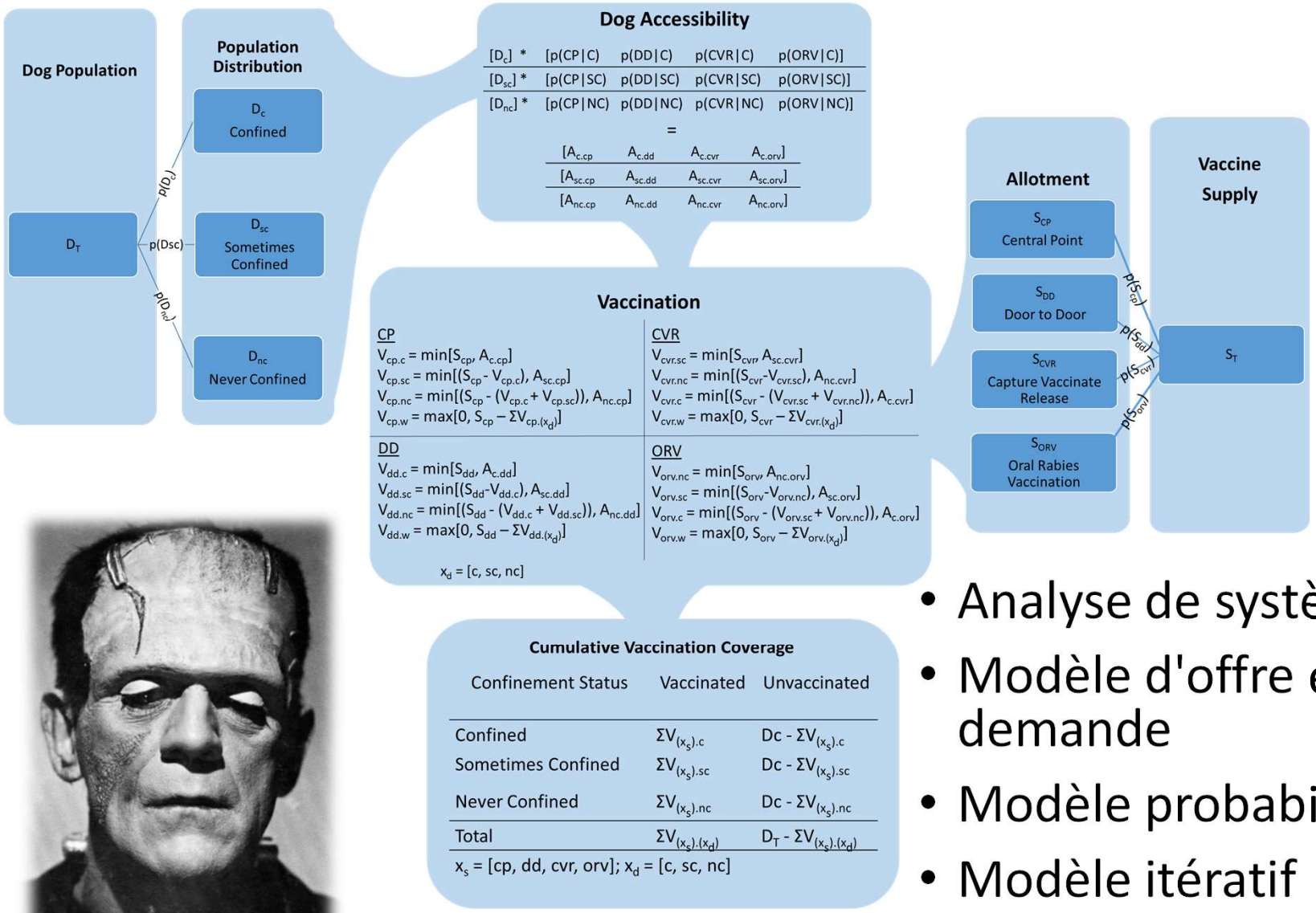
Questions?

Figure 8. Rabies elimination rank scores by rabies clusters



Notes: Elimination rank scores were estimated for each rabies cluster (4) based on six criteria: proportion of the cluster considered rabies-free, funding gap for elimination, dog vaccination coverage for 2015 estimates, gap in vaccination workforce, average years to achieve elimination, and average human development index. Rank scores ranged from 16 to 84. A low rank score represents a theoretically easier pathway towards elimination.

Panification de la Vaccination: la méthode



- Analyse de systèmes
- Modèle d'offre et de demande
- Modèle probabiliste
- Modèle itératif
- Modèle de classement